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MAY 30 1925

# GARTON—DANIELS AND KEYSTONE LIGHTNING PROTECTIVE .. APPARATUS ..



**ELECTRIC SERVICE SUPPLIES CO.**

PHILADELPHIA

NEW YORK

CHICAGO



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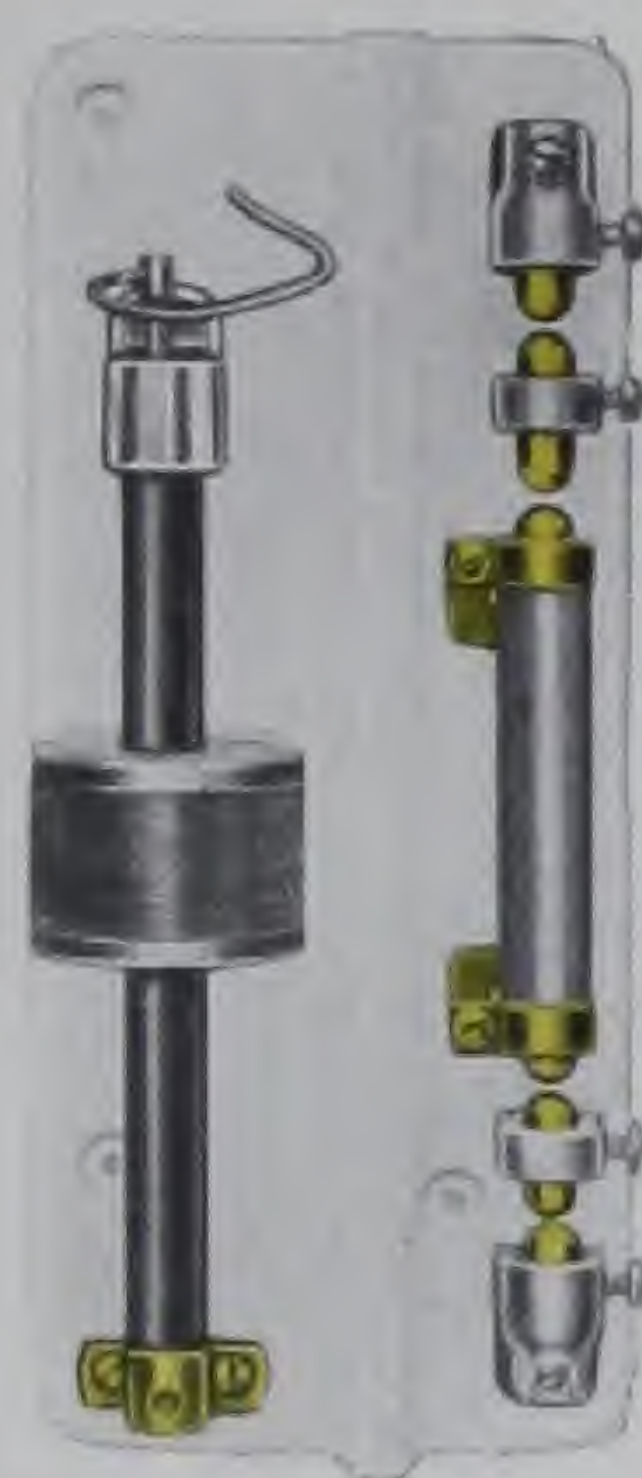


986-10.

# Garton-Daniels and Keystone Lightning Protective Apparatus



Keystone  
Expulsion Arrester



Garton-Daniels A. C.  
Station Arrester



Garton-Daniels  
D. C. Pole Arrester

Bulletin No. 175

February 15th, 1921

## ELECTRIC SERVICE SUPPLIES Co.

Manufacturers of

Railway Material and Electrical Supplies

PHILADELPHIA  
17th and Cambria Streets

NEW YORK  
50 Church Street

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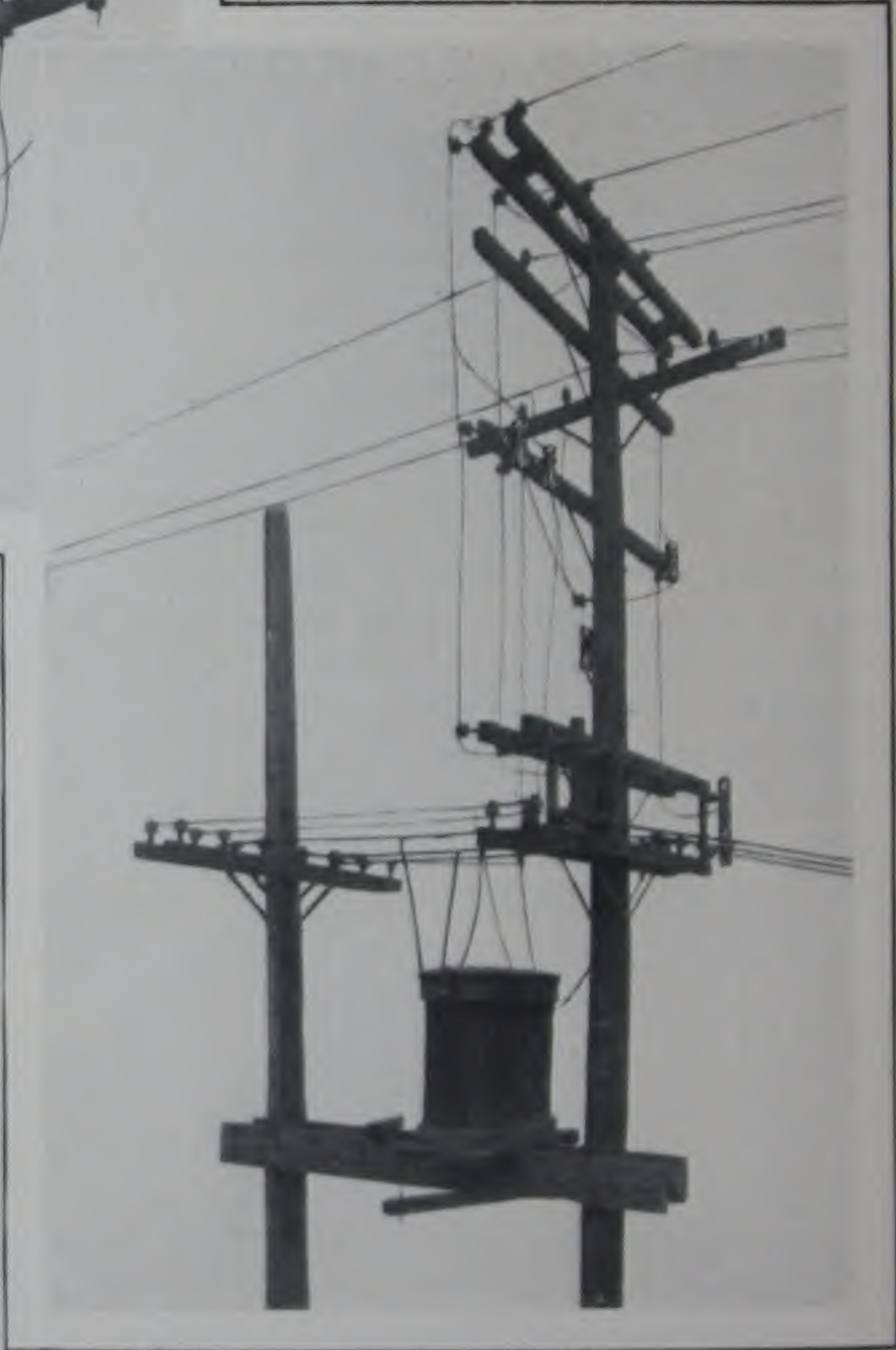
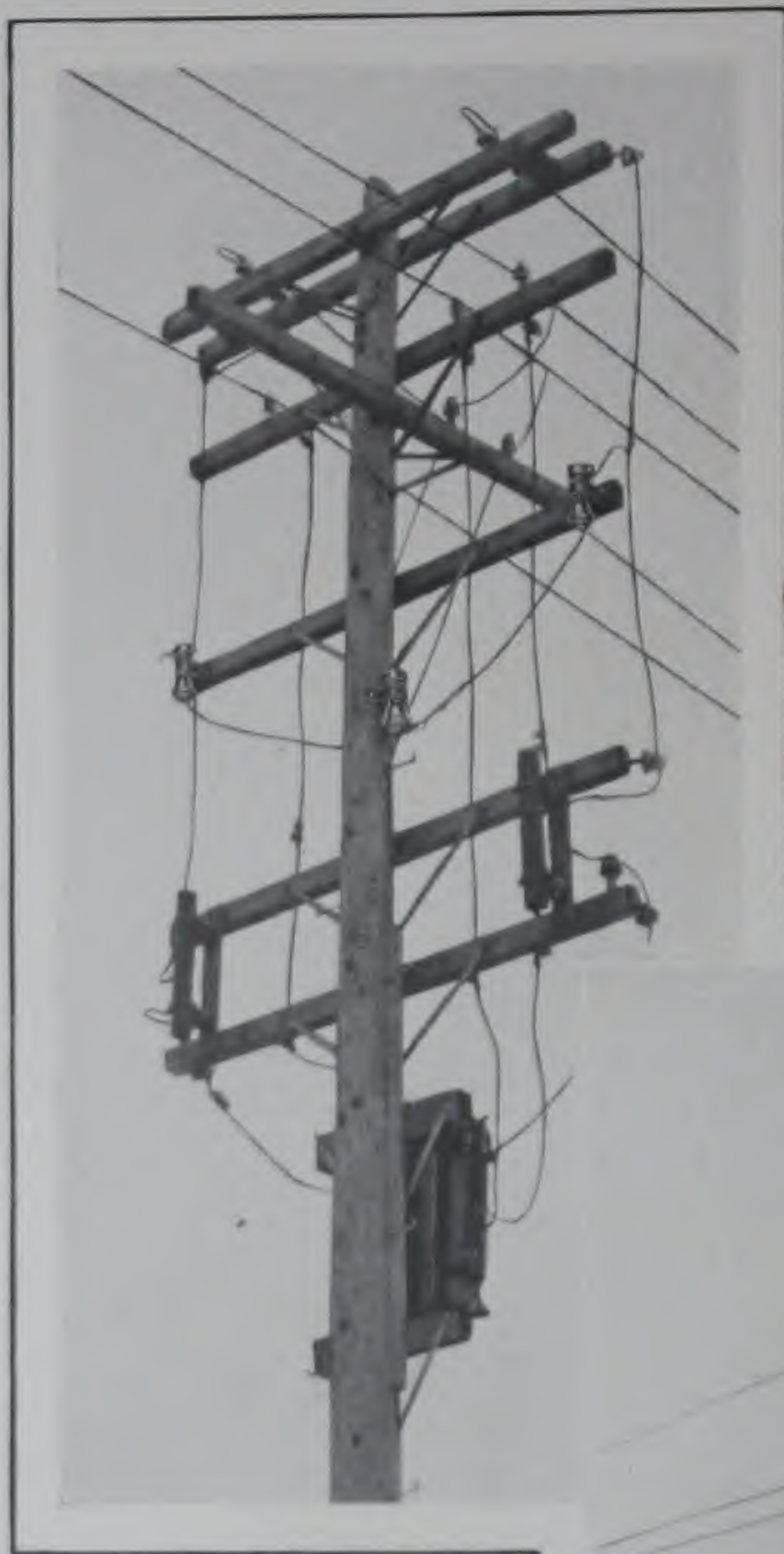




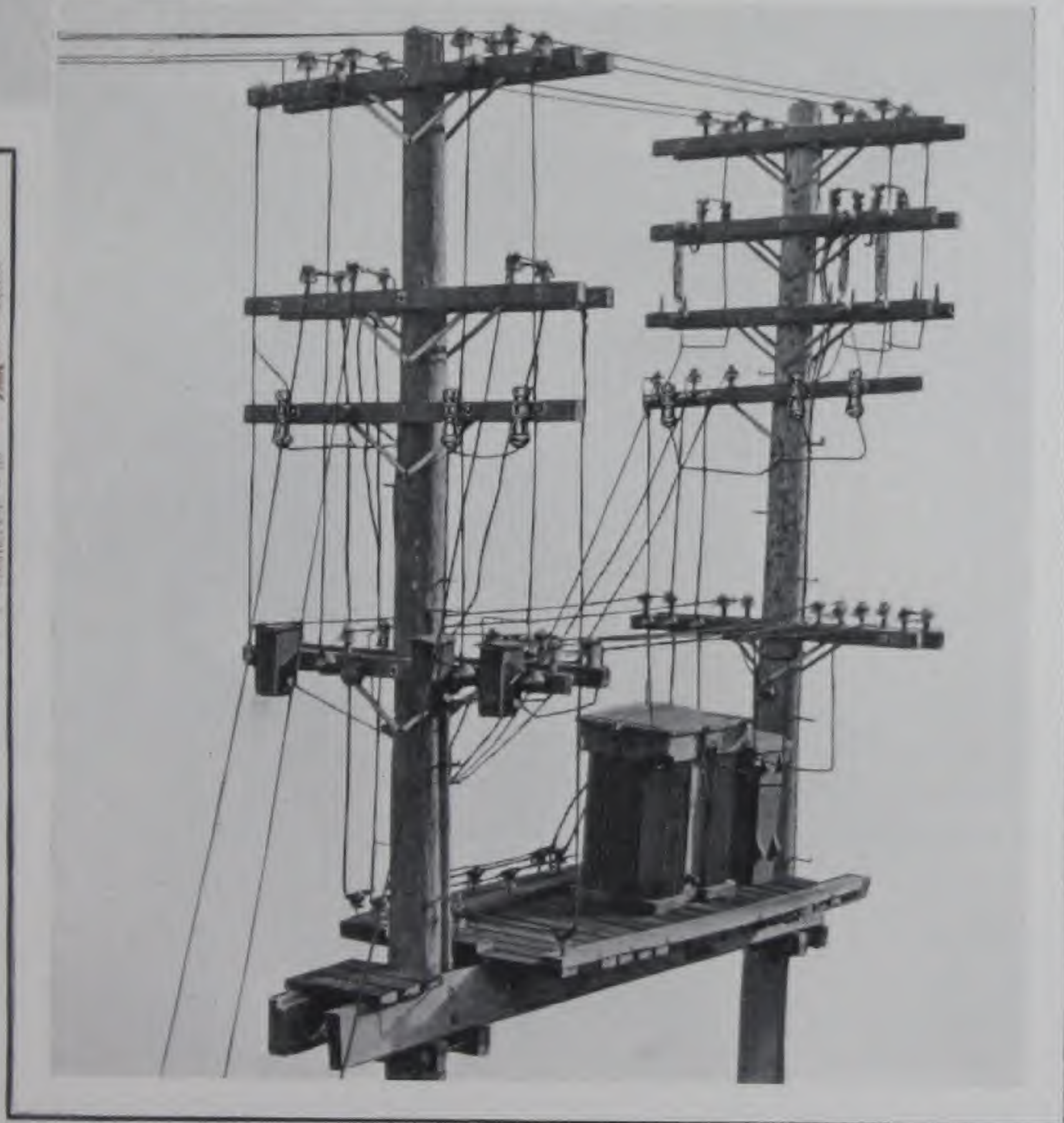
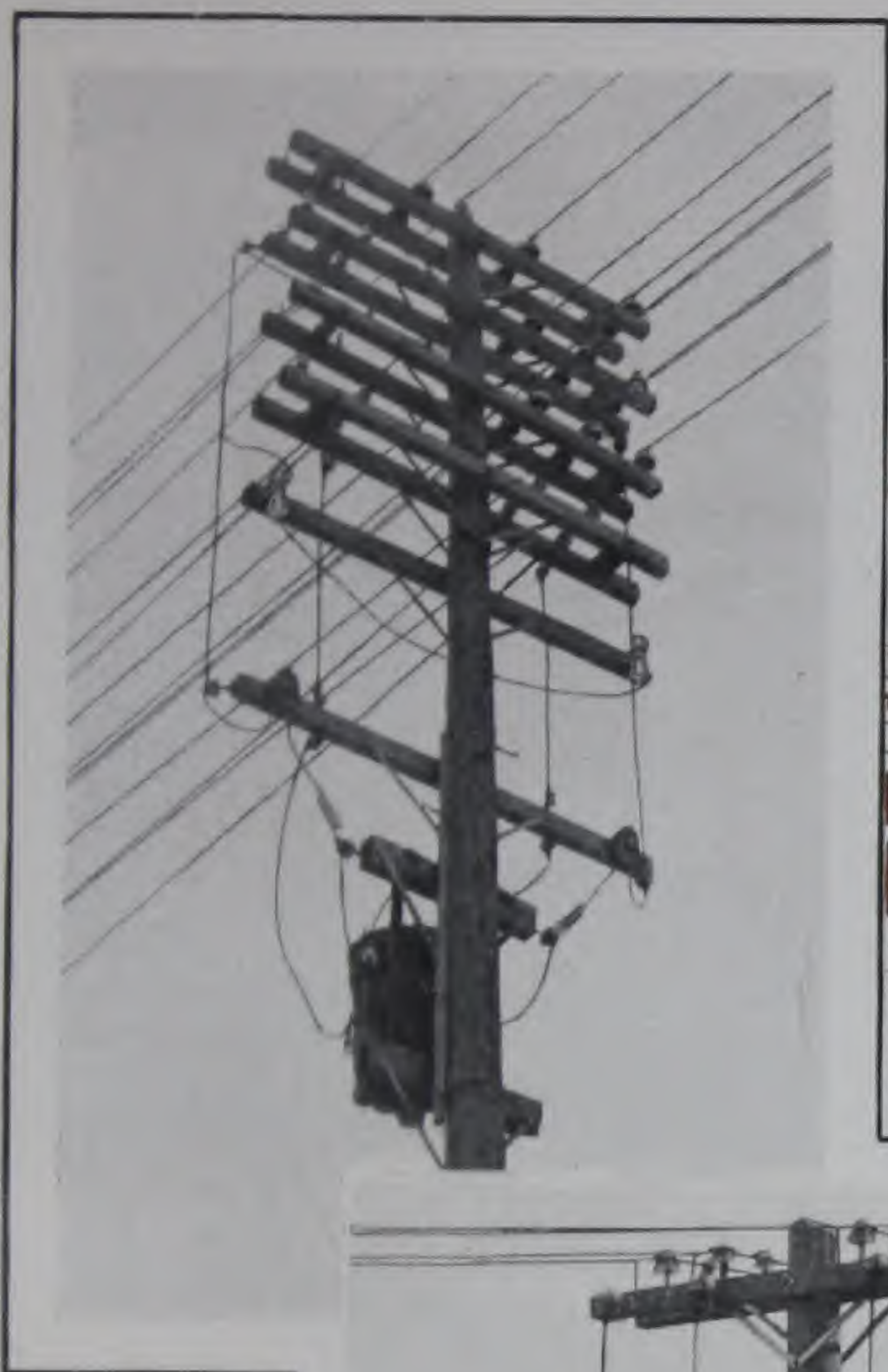
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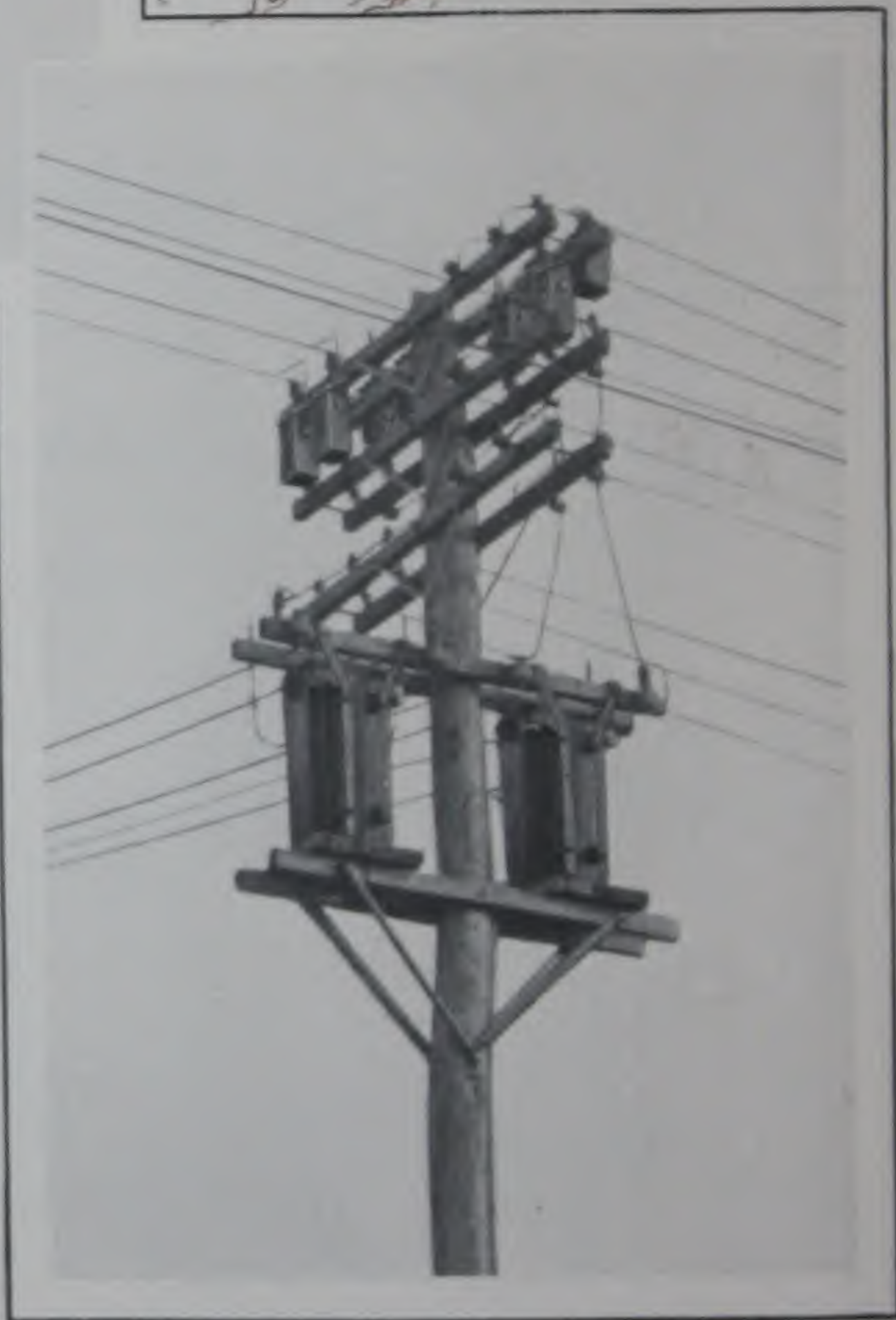














## KEYSTONE LIGHTNING ARRESTERS

### Expulsion Type



During the past few years there has been done a great deal of valuable experimental work on the protection of transformers from lightning, particularly on the effects of various methods of lightning arrester installation on the continuity of service based on the reduction of burned-out transformers and blown fuses, the most elaborate experiments along this line having been conducted in the city of Chicago.

Here there was available a distribution system covering about 180 square miles and supplying about 400,000 customers through approximately 20,000 transformers; the results of this investigation covering, as it does, a period of time extending over eight years, may be taken as embodying the latest and best information available on this important subject.

These experiments have led to the following important conclusions:

(a) The older practice of installing lightning arresters at regular intervals of perhaps 2 or 4 to the mile is not a satisfactory method for the protection of transformers on the modern distribution system. The practice of installing arresters even on the poles adjacent to transformers at times proves inadequate.

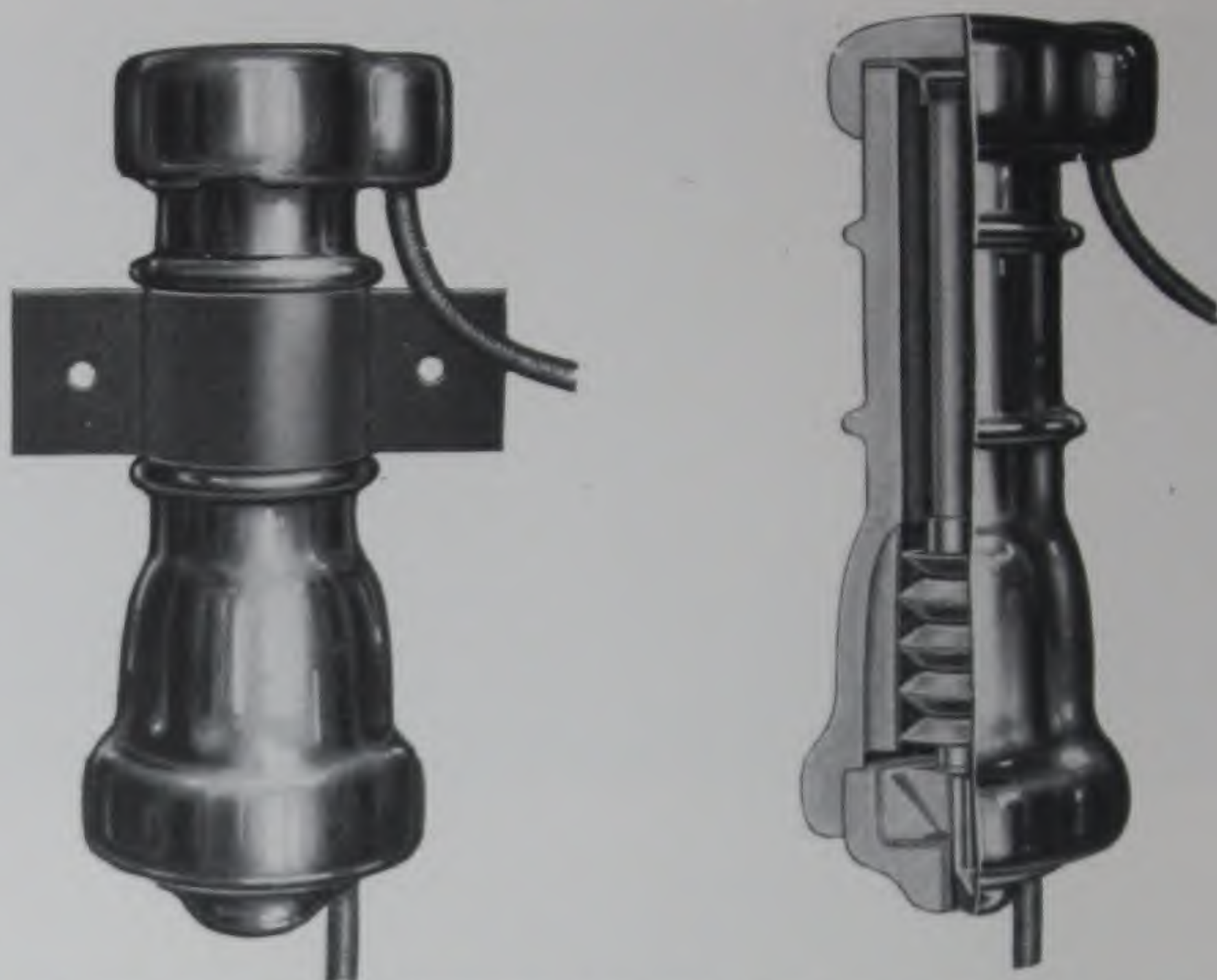
(b) To secure thoroughly adequate protection for line transformers requires each transformer, irrespective of capacity or service in which used, to be protected with a lightning arrester installed on the transformer pole.

(c) Lightning troubles can be still further reduced by the re-



## KEYSTONE LIGHTNING ARRESTERS

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Figures 1 and 2—Showing General Appearance and Internal Construction of Expulsion Lightning Arrester

moval of the transformer primary terminal boards.

(d) That the density of lightning arrester installations per square mile has a very important bearing on the protection afforded to apparatus—the greater the density the greater the degree of protection afforded. It is also apparently the case that these two factors can be connected by a well-defined mathematical equation of the exponential type.\*

The desirability of protecting every transformer with a lightning arrester installed on the transformer pole as well as installing line arresters where relatively long stretches of line would ordinarily be unprotected, immediately leads us to a consideration of the features which a lightning arrester must have to prove desirable for this service.

First of all, there will be numerous small transformers to protect; these are relatively cheap in first cost and do not produce a great deal of revenue; the arresters used for their protection must be inexpensive in first cost, must be easy and cheap to install and must require little or no inspection. These same characteristics of arresters apply with

\*For more detailed and complete information on these studies the reader is referred to a paper, "Studies in Lightning Protection on 4000 Volt Circuits," by D. W. Roper, Jour. Am. Inst. of Elec. Engrs., Nov., 1920, pp. 960-975, Inc.



## KEYSTONE LIGHTNING ARRESTERS

### Expulsion Type

equal force to those installed on the line at locations other than transformer installations.

Then there comes the medium or average size transformer; there will be many of these to protect on the average distribution system, and an arrester possessing the same characteristics as mentioned above will prove desirable for this service as well.

Finally there comes the large transformer installations, and the installations serving very important customers, installations where continuity of service is of the very greatest importance. For this latter service, and for the protection of important station apparatus as well, one is justified in a larger expenditure for the most efficient lightning protective apparatus that is obtainable; and for this service the standard line of Garton-Daniels Lightning Arresters and Lightning Protective Apparatus cannot be too highly recommended; for over a quarter century it has proven its efficiency and reliability in properly protecting electrical apparatus under the most severe conditions.

To meet the two conditions first mentioned we have developed a line of "Keystone" Lightning Arresters—"The Expulsion Arrester"—many thousands of which have been sold during the five years it has been on the market. These arresters combine in a marked degree the desirable features of low first cost, ease and cheapness of installation, ease of inspection and very desirable operating characteristics. They are not at all designed to supplant or supersede our standard Garton-Daniels Lightning Arresters, which arresters we recommend as being the most efficient and reliable on the market, and which we recommend for use in protecting important line and station apparatus.

The Expulsion Arrester fills the demand for an inexpensive arrester, an arrester that is self-contained, that is easy to install and inspect, that is small enough to be installed on the transformer pole without crowding and that will give efficient lightning protection.

### Construction and Operation

A general view of the Expulsion Arrester is shown in Figure 1; Figure 2 shows a section of the arrester in phantom, from which illustration a good view of the internal construction may be obtained. This, in conjunction with Figure 3, showing a sectional view, will enable one to get a clear idea as to the principles underlying its operation.

The arrester consists of a porcelain housing or barrel, "A," closed at the top with porcelain cap "B" cemented thereon, and at the bottom with porcelain plug "C" cemented therein. The barrel is provided with supports "D-D" for the strap-iron hanger "E," by which the arrester is mounted directly on the cross arm or other suitable support.

Lead "F" is connected to line; this lead connects with a heavy brass contact plate "G" provided with downwardly projecting lips, which make contact with a sprayed copper band on upper end of



## KEYSTONE LIGHTNING ARRESTERS

## Expulsion Type

resistance rod "H"; to the lower end of the resistor is secured the clamping band "I," which, being provided with a lip, serves as support for the insulating member "S." Air gap elements are assembled on rod "S," the gaps being formed between brass discharge caps "J-J" by the interposed porcelain spacers "K-K," both of which are permanently secured in place by discharge point "M," whose upper end is enlarged and tapped for threading on to lower end of rod "S" and securely locked thereto by means of pin "L."

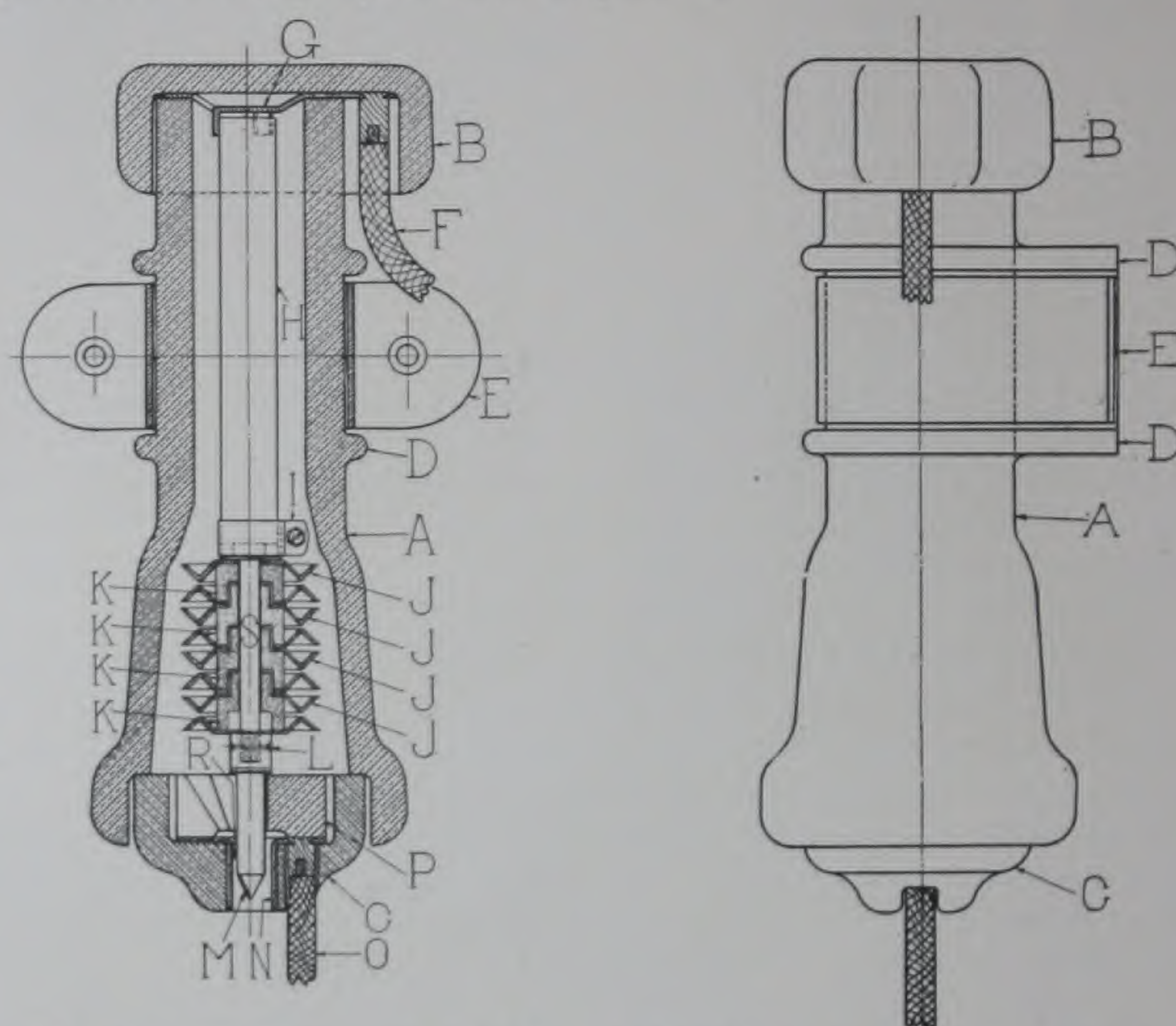


Figure 3—Diagrammatic View of Expulsion Lightning Arrester

Discharge point "M" is enclosed in brass tube "N," but is entirely separated therefrom by small air gap "R"; brass tube "N," in turn, is connected to ground lead "O." Discharge point "M" is held absolutely central with angular brass tube "N" by means of porcelain blocks "P" which are cemented in bottom plug "C."

It will be noted that the construction of the arrester is simple in the extreme, and of prime importance is the unit internal construction, the fact that all the constituent parts of the internal assembly are rigidly and permanently connected and held together, the porcelain barrel or housing performing only the two essential functions of protecting the internal assembly from the elements and of offering a means of attaching the arrester to suitable supports.

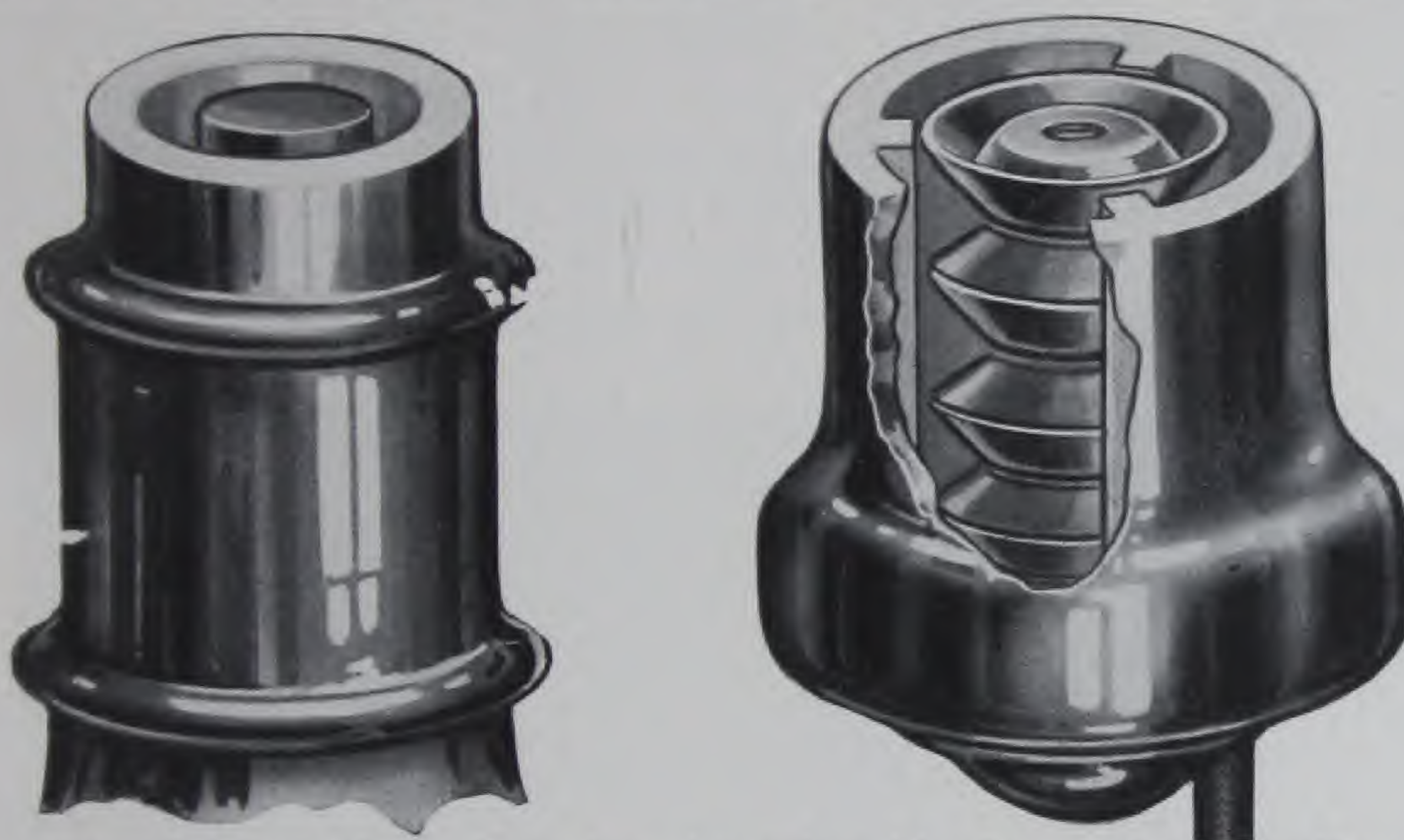


## KEYSTONE LIGHTNING ARRESTERS

## Expulsion Type

Lightning discharges enter line wire "F" and take the path through plate "G," resistor "H," clamping band "I," gaps "J-J-J-J," discharge point "M," expulsion gap "R," brass ring "N," ground lead "O" to ground.

In actual service there will always be a certain amount of line or dynamic current following the lightning discharge to ground; this may vary anywhere from a small capacity current, where the arrester is installed on an ungrounded circuit, to a very heavy current, where the arrester is installed on a dead grounded circuit, for example, a three phase Y connected grounded neutral circuit, so many of which are in operation. On any arrester there must be some sure and positive means for interrupting these flows to ground else they will maintain,



Figures 4 and 5—Showing Annular Air Space Surrounding Resistor and Discharge Caps of Expulsion Arrester

ground and short-circuit the line and interrupt the service. The unique method by which the Expulsion Arrester interrupts these dynamic current flows to ground will be understood, from the following:

In all cases, whether the dynamic flow be light or heavy, it takes identically the same path from line to ground as is taken by the lightning discharge. When the flow is small it is extinguished by the actions of the air gaps "J-J-J-J" and the main expulsion gap "R" at the zero point of the generator voltage wave. However, as has been said, there will be times when this flow of dynamic current to ground will be heavy; if the Expulsion Arrester depended only on the arc-extinguishing properties of the air gaps for disrupting this dynamic flow, to make it positive the arrester would require incorporated in its design either of the two following features:

(a) A high resistance used in series with its present small air gap distance, or

(b) A greatly increased air gap distance used in series with its present low series resistance.



## KEYSTONE LIGHTNING ARRESTERS

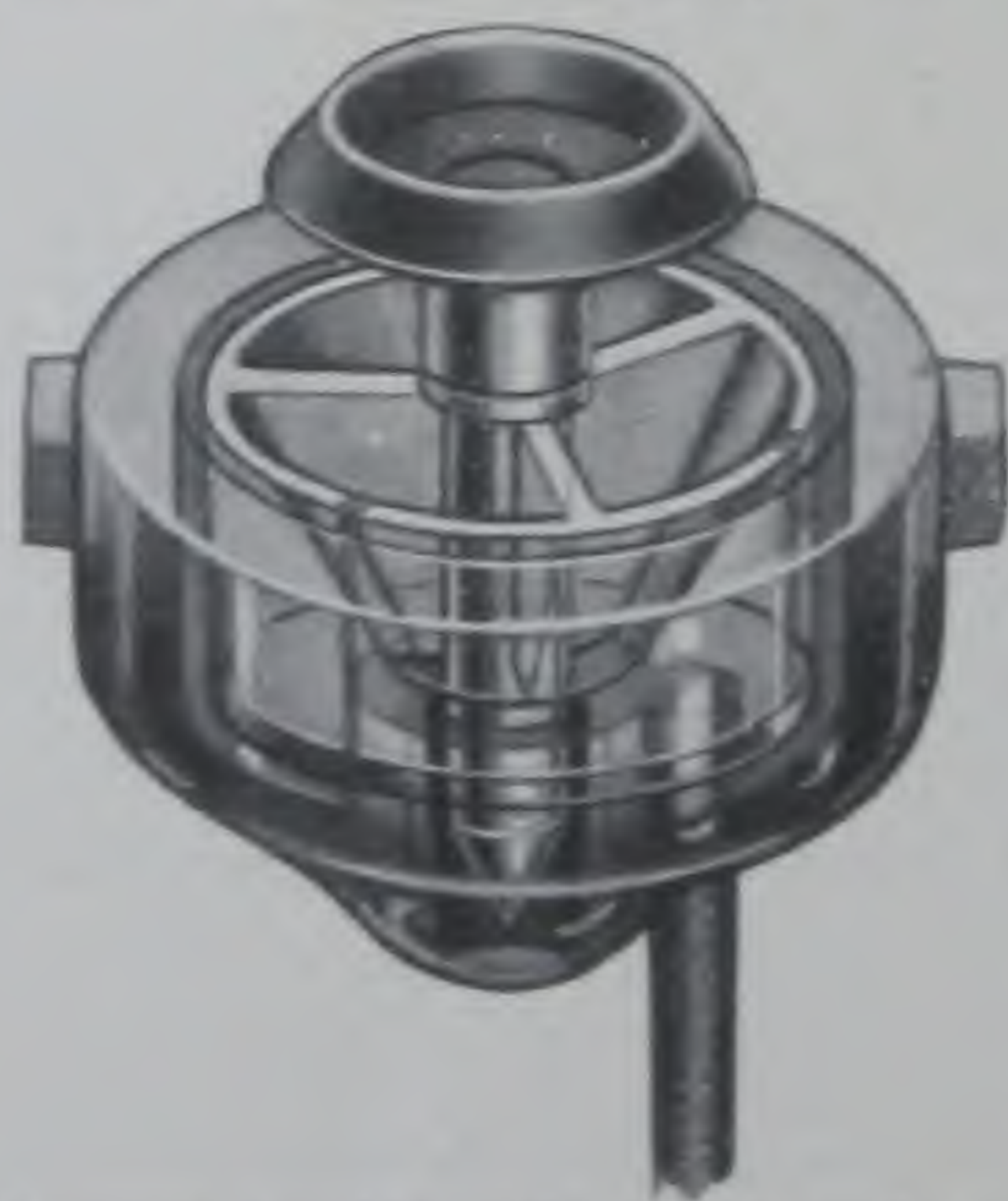
### Expulsion Type

If method (a) were employed it would mean that the discharge capacity of the arrester would be greatly reduced, so materially decreasing its efficiency as a lightning protective device.

If method (b) were employed it would mean that the arc-over voltage of the arrester would be greatly increased, so again materially decreasing its efficiency as a lightning protective device.

Instead of having recourse to either of these methods the Expulsion Arrester utilizes a very novel principle for extinguishing these dynamic current flows; a principle which enables it to utilize a low series resistance and a small air gap distance; a principle which enables it to be built along lines which are fundamentally correct and efficient; a principle which enables it to offer in combination with these features a positive and sure means of extinguishing all flows of dynamic current from line to ground, whether they be heavy or light.

It will be noticed from Figure 4 that there is an annular air space between resistor "H" and the inside of main barrel "A"; the same will be noticed in the air space between discharge caps "J-J-J-J" and the inside of the barrel "A"; three air chutes extend through porcelain block "P" (see Figure 6), opening into the air through annular gap "R." When dynamic current flows from line to ground through the arrester, it creates arcs between discharge caps "J-J-J-J"; also an arc in the annular or main expulsion gap "R." The current flowing through resistor "H" creates a certain amount of heat; the arcs formed between discharge caps "J-J-J-J" do likewise; this heat is rapidly transmitted to the surrounding air, which, of course, immediately expands. As the arrester is sealed at the top, the only outlet for this expanding air is down the air chutes in block "P" and through the main expulsion gap "R."



*This sudden blast of air blows out the arc in gap "R," and this being interrupted, the arcs between discharge caps "J-J-J-J" simply die out.*

It will at once be seen how entirely automatic and positive this method of arc extinguishment is; if the flow of dynamic current is slight, the heat created within the arrester is small, the expulsion effect is small and the air gaps are entirely sufficient to extinguish the flow at the end of the first half cycle of the generator wave. When the flow becomes heavier we still de-

pend to a certain extent on the arc-extinguishing properties of the air gaps, but this heavier flow creates more heat and causes a heavier blast of air to be expelled through expulsion gap "R." And with still heavier flows we get a still heavier blast of air through the main expulsion



## KEYSTONE LIGHTNING ARRESTERS

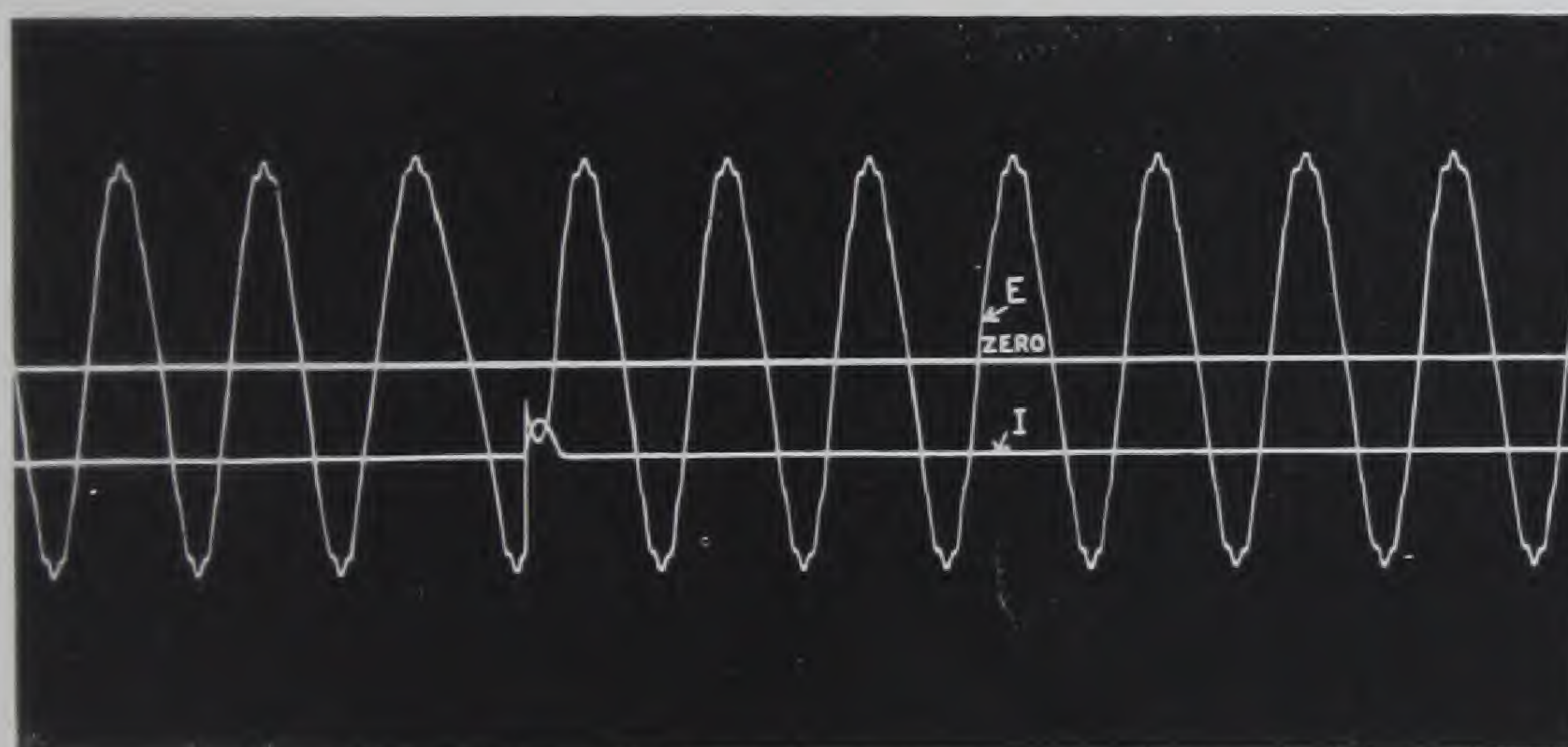
### Expulsion Type

gap "R" to assist the air gaps in extinguishing the flow of current to ground.

*The heating value of a current depends on the square of its value ( $H=RI^2$ ); if, therefore, we get any certain expulsion blast with any given current, if we double the current, we will get four times the heating effect and approximately four times the expulsive effect of the first blast, if we have four times the current we will get sixteen times the heating effect and approximately sixteen times the expulsive effect of the first blast.*

Therein lies the peculiar and unique feature of the Expulsion Arrester; by means of its construction it is possible to secure a highly efficient arrester, both from the standpoint of low arc-over value on account of the small air gap distance used, and high discharge capacity because of the low series resistance employed; and at the same time secure maximum arc-disrupting ability on account of the peculiar characteristics of this expulsion effect when applied to lightning arrester construction.

### Oscillographic Records



Oscillogram A

*Arrester—Type EX, Form 3, rated for 2500 Volt 3 phase grounded Y circuit.*

*Test Voltage—3000.*

*Dynamic current flow—7.3 amperes.*

*Duration of current flow—26 cycle or .0043 second.*

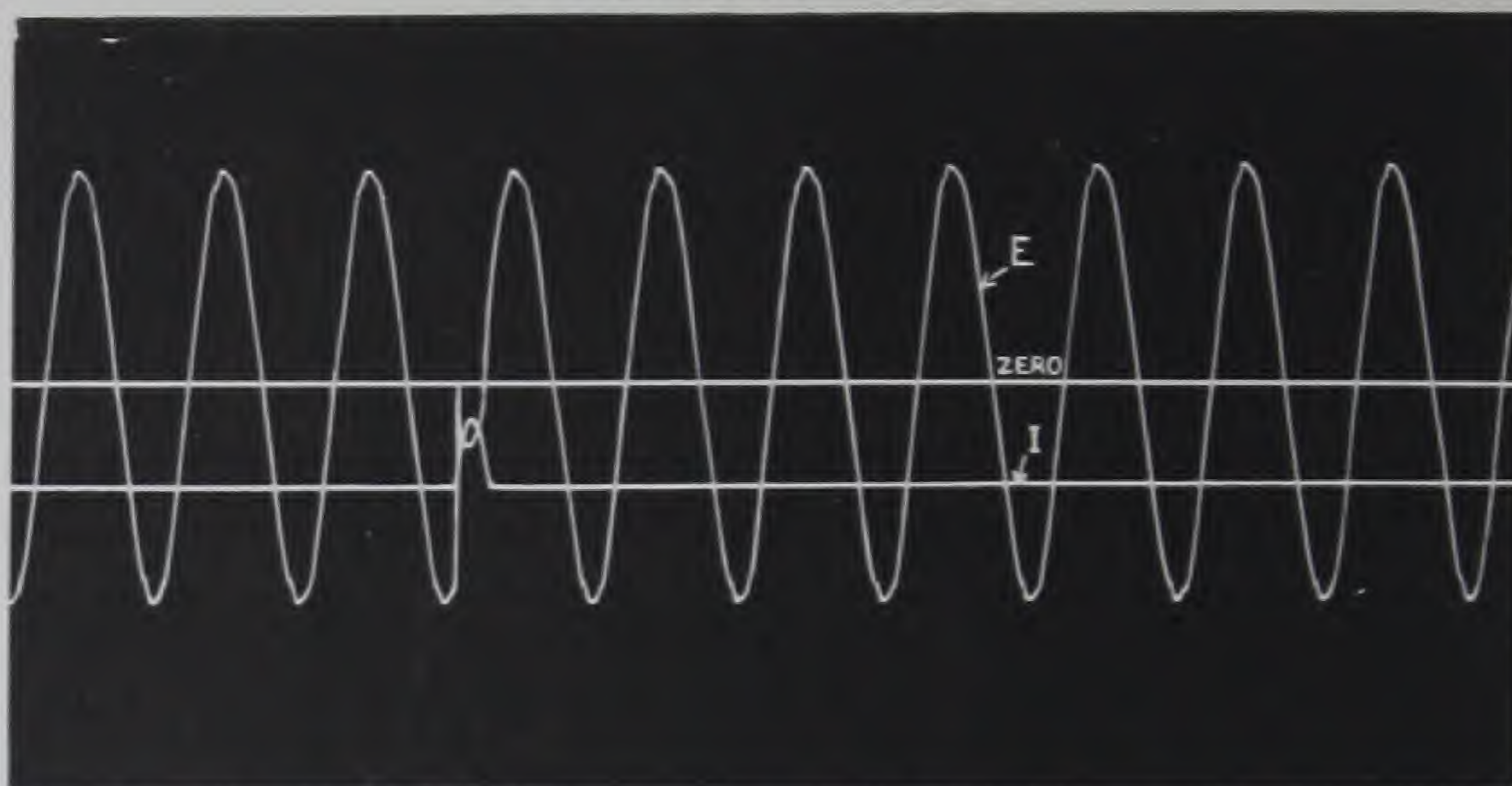
Oscillographic records show very beautifully the phenomena occurring during the operation of the Expulsion Arrester; three typical records are shown; these were made on a Type EX, Form 3 Arrester, rated for operation on a 4150-2400 volt 3 phase grounded Y circuit; oscillograms are given showing normal operation with approximately phase-ground voltage impressed across the arrester, as well as under abnormal operation when the arrester is subjected to the full phase-phase voltage of the circuit.

In Oscillograms A and B it will be noted that the static discharge occurred on the descending wave; the maximum current impulse is relatively low and, as seen, is extinguished by the arrester in very short time intervals. In Oscillogram C the discharge occurred on the ascending point of the wave, and in this case, as the arrester was receiving the full phase-phase voltage of the



## KEYSTONE LIGHTNING ARRESTERS

## Expulsion Type



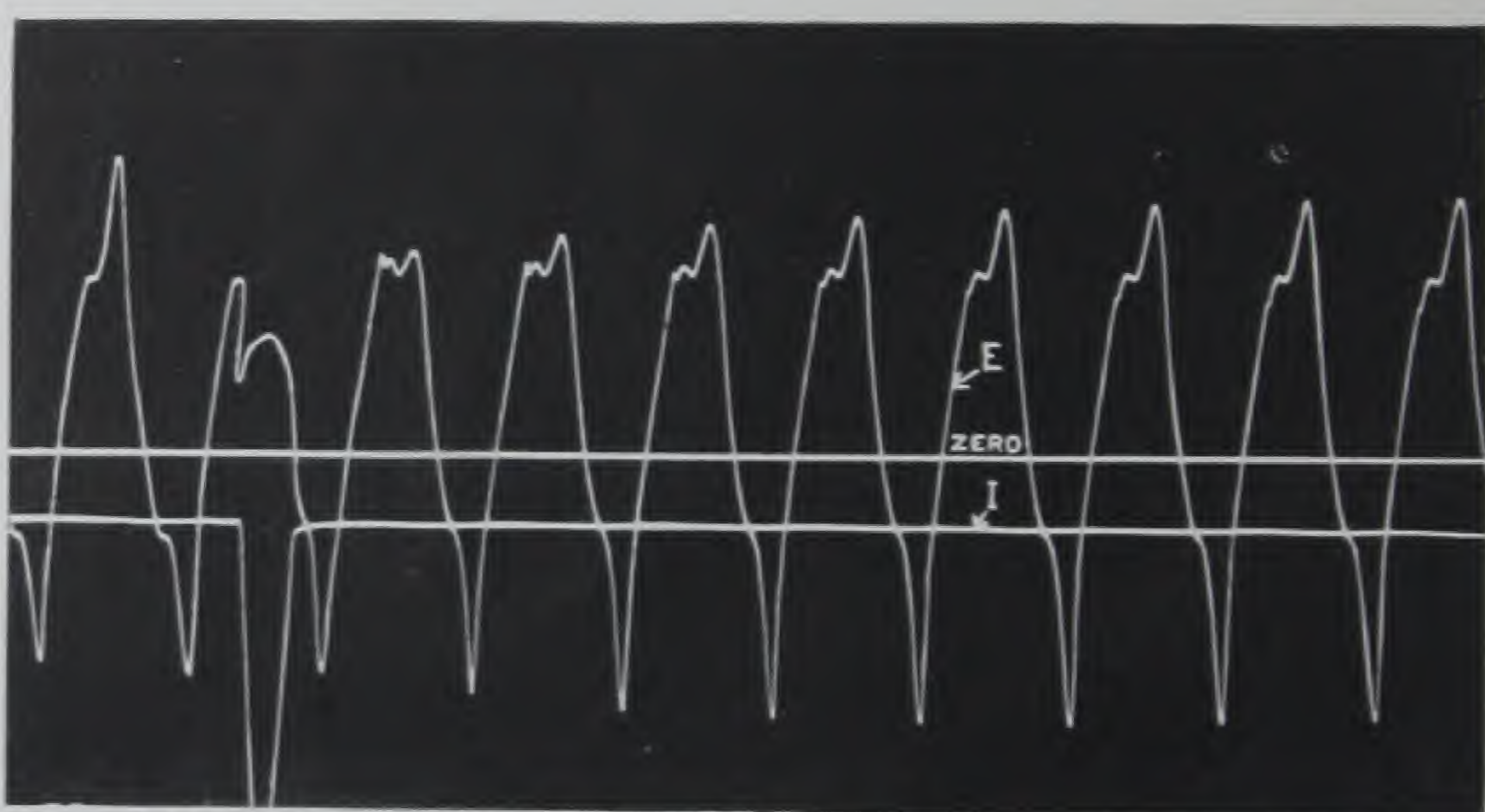
Oscillogram B

*Arrester—Type EX, Form 3, rated for 2500 Volt 3 phase grounded Y circuit.*

*Test Voltage—3000.*

*Dynamic current flow—8.0 amperes.*

*Duration of current flow—.22 cycle or .0036 second.*



Oscillogram C

*Arrester—Type EX, Form 3, rated for 2500 Volt 3 phase grounded Y circuit.*

*Test Voltage—4150.*

*Dynamic current flow—15.3 amperes.*

*Duration of current flow—.34 cycle or .0056 second.*

circuit, it was operating under conditions equivalent to the worst that could occur in actual service. Here the current flow of 15.3 amperes was extinguished in .0056 second, or in approximately one-third of a cycle.

The irregular voltage wave noted was probably due to factors in the design of the transformer used for the test.

These oscillograms show clearly not only the positive action of the Expulsion Arrester, but also the fact that during operation they produce no harmful effects on the circuit to which connected—two factors which should always be borne in mind in the selection of lightning protective apparatus.



## KEYSTONE LIGHTNING ARRESTERS

### Installation

Expulsion Arresters may be freely employed in protecting all classes of electrical apparatus, and particularly where "100 per cent. protection" is desired; that is, where every transformer on a circuit is protected. They are not designed to supersede our line of standard Garton-Daniels, or circuit breaker type, lightning arresters, but merely to augment this line by providing relatively inexpensive, self-contained arresters, which are both efficient and durable, and which permit of easy and cheap installation and maintenance.

When protecting transformers or other apparatus installed on ungrounded circuits, one arrester should be installed on each line wire, the ground wires tied together and run to a common ground. They should, whenever possible, be installed on transformer poles where protecting this class of apparatus, and, generally speaking, should be installed close to any apparatus which they are to protect.

When protecting transformers on dead grounded neutral circuits, one arrester should be installed on the line wire; a tap from the grounded wire and the ground wire from the arrester should be tied together and run to a common ground.

When protecting transformers on grounded neutral circuits, when the neutral wire is grounded only at power or sub-stations, one Expulsion Arrester should be installed on the line wire and a small spark gap arrester (see types N and NS Neutral Arresters listed on page 20) connected between the neutral wire and earth. Ground wires from the two may be tied together and run to a common ground.

### Grounding

Grounding Expulsion Arresters is no different from grounding other arresters. All grounds should be good and should be maintained in good condition if full efficiency is to be expected from the lightning arrester installation. *Bear in mind that lightning arresters can't have too good a ground.*

Among the general rules for grounding Expulsion Arresters may be mentioned the following:

1. Provide short, straight wires from line to arrester and from arrester to ground. Wire of No. 6 B&S gauge or larger should be used in all cases.
2. When a turn is necessary, avoid sharp angles by carrying the wire in a curve of long radius.
3. The arrester should be installed in a vertical position *with the open end down.*
4. Do not bend the ground lead so that it comes directly under the open end of the expulsion tube in the bottom of the arrester. Bend it backwards so that it clears the end of the tube. This allows the full force of the expulsion blast to blow downwards without meeting any obstructions.
5. Solder carefully and tape all joints and connections.
6. Run all arresters installed on the same pole to a common ground wire.
7. Soldered joints underground should be given a coat of preservative paint.
8. For further and more complete information on lightning arrester grounds, both pole and station types, see our bulletin on "Grounding Lightning Arresters." Copies will be sent upon request.

See page 42 of this bulletin for listing of ground fittings.

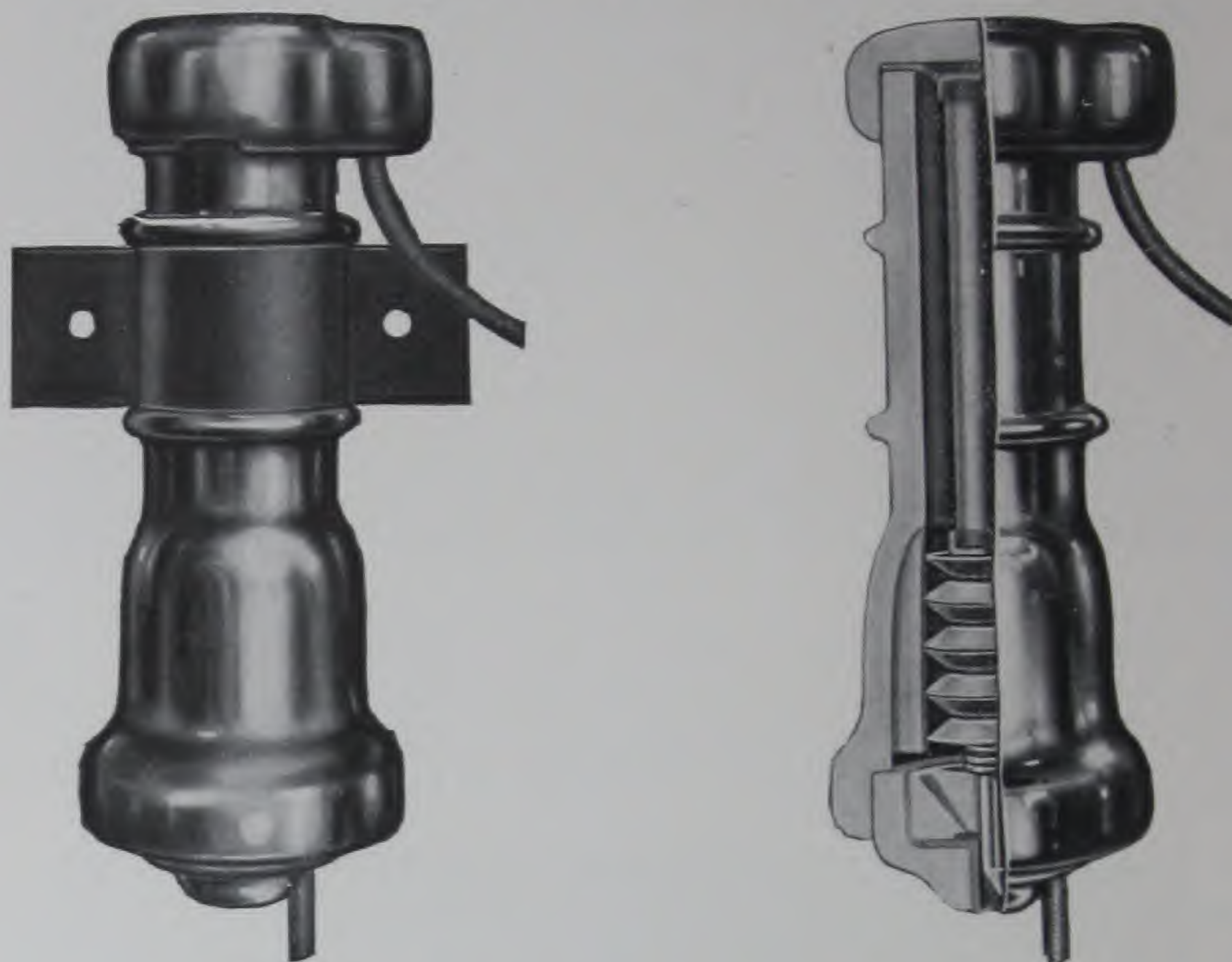
### Inspection

No inspection of an Expulsion Arrester other than a visual inspection from the ground is necessary. Being entirely self-contained one can see at a glance whether it is in good condition or not. This is a decidedly good feature, as where large numbers of them are installed, inspection costs are reduced to a very small item.



## KEYSTONE LIGHTNING ARRESTERS

Expulsion Type—350 to 3500 Volts, A. C.



Expulsion Type Lightning Arrester, Showing General Appearance and Internal Construction

Keystone expulsion type lightning arresters have been designed to fill the demand existing for a relatively inexpensive lightning arrester, an arrester that is self-contained, one that is easy to install and inspect, that is small enough to be installed directly on the transformer pole without crowding, and one that gives efficient and reliable lightning protection.

The illustrations above show both the general appearance and internal construction of the arrester; when installed, the upper terminal is connected to the line wire, the lower terminal to ground; the strap iron serves to attach the arrester to the cross arm or other suitable supporting means.

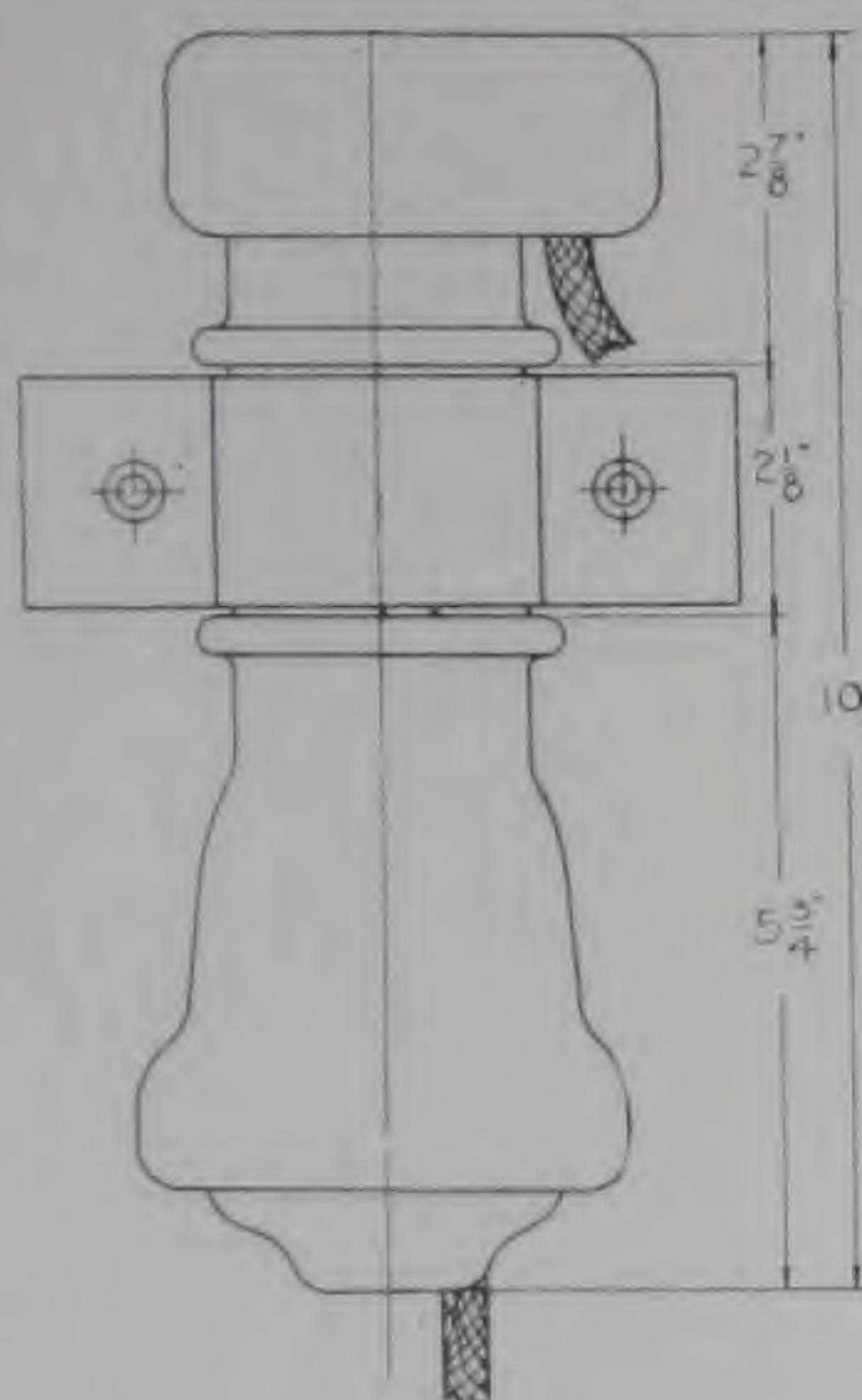
For interrupting the flow of dynamic current following the lightning discharge to ground, two means are employed. When it is small it is extinguished by the air gaps at the end of the first half cycle of the generator wave. When it is large, as happens on a grounded circuit or where two phase wires discharge simultaneously, recourse is had to another means of extinguishing the flow to ground.

The dynamic current flowing through the resistance rod creates a certain amount of heat; the same is true of the arcs formed at the inner gaps; this heat is rapidly transmitted to the air surrounding both the resistance and gaps, causes it to expand and as the arrester is sealed at the top the only

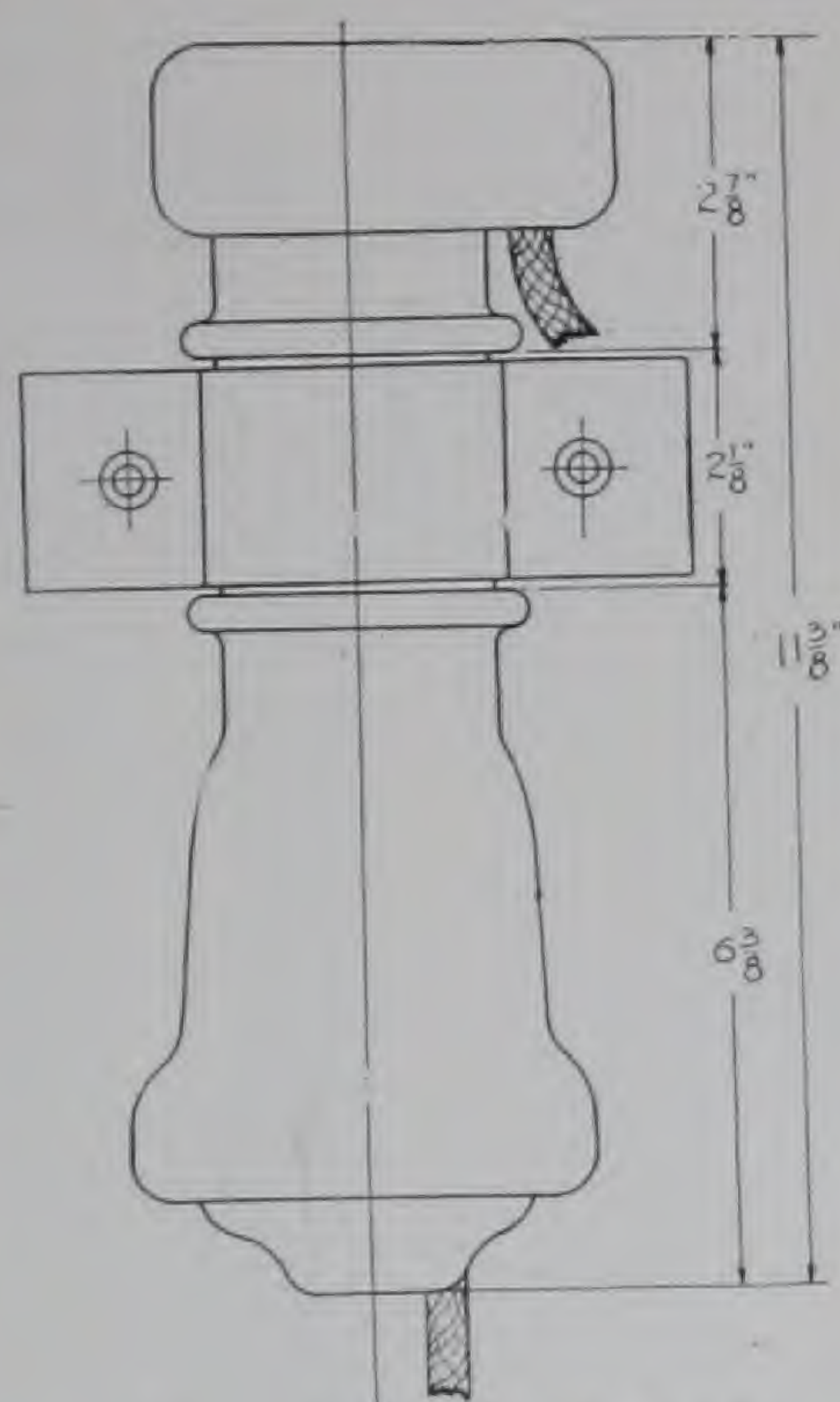


## KEYSTONE LIGHTNING ARRESTERS

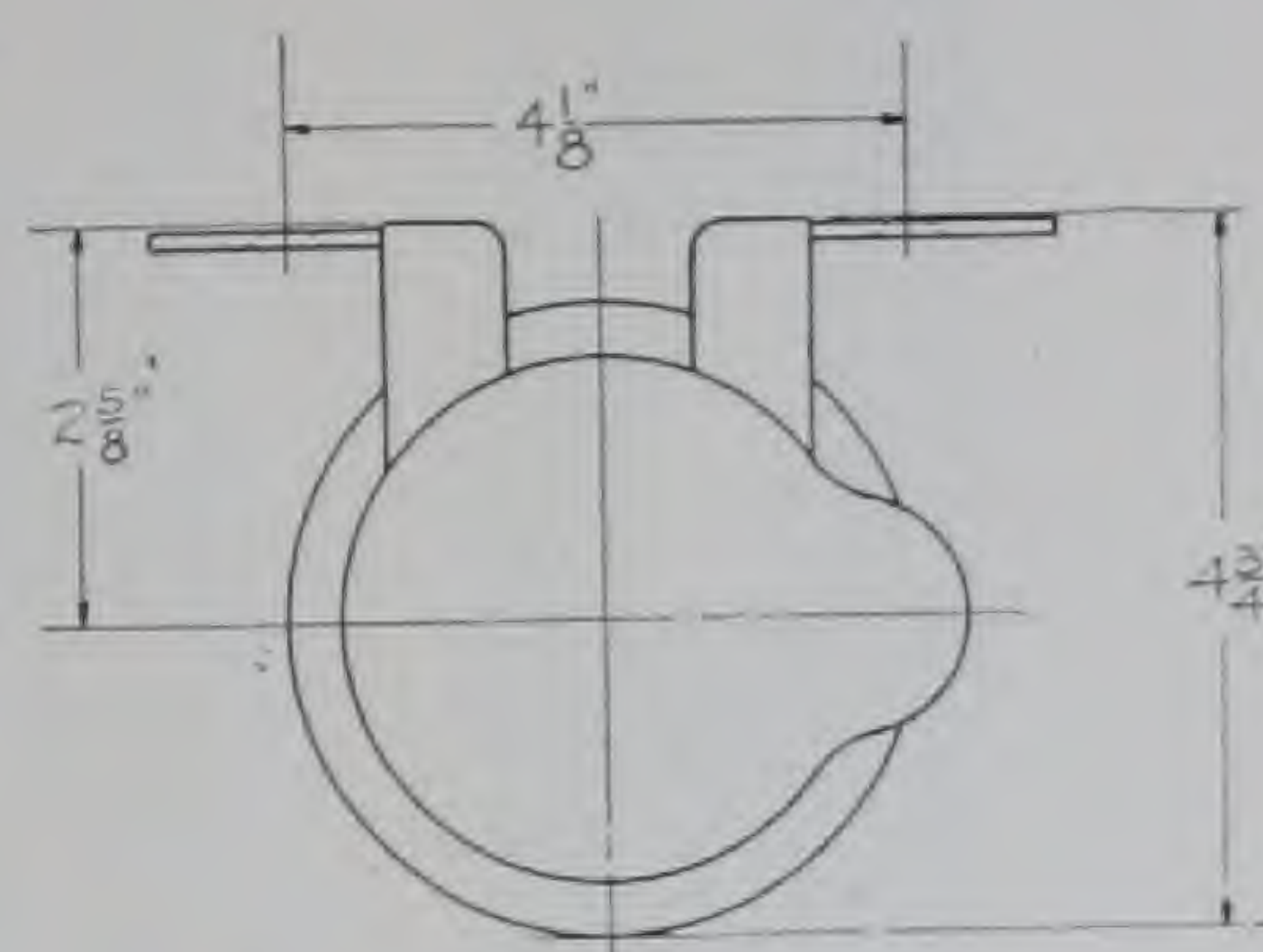
Expulsion Type—350 to 3500 Volts, A. C.



Nos. 50672 and 50632



Nos. 50633 and 50636

Nos. 50672, 50632, 50633  
and 50636

path for this expanding air to flow is through the expulsion gap to atmosphere. This sudden rush or blast of air through the expulsion gap simply blows out the arc at the gap and so cuts off the flow of dynamic current to ground. The operation of the arrester is simple in the extreme, is very positive and efficient.

Expulsion arresters are entirely self-contained, being housed in a glazed porcelain body and arranged to be supported from the cross arm or other suitable support by means of a strap iron hanger fitting over a section of the main body as shown. This hanger is 12-gauge metal drilled on 4 1/8-inch centers with holes for accommodating No. 14 wood screws or 1/4-inch lags.

Each arrester is provided with line and ground leads of No. 6 B&S gauge 7-strand cable, 12 inches long.

Type EX, form 0, arresters are for use on circuits of from 350 to 1200 volts, maximum phase—phase voltage.

Type EX, form 1, arresters are for use on circuits of from 1200 to 2500 volts, maximum phase—phase voltage.

Type EX, form 2, arresters are for use on circuits of from 2500 to 3500 volts, maximum phase—phase voltage.

Type EX, form 3, arresters are for use on 2500-volt 3-phase Y circuits *operating with grounded neutral*, and having a phase—phase voltage of approximately 4200. They are also for use in 2500-volt 2-phase three-wire circuits *operating with grounded neutral*, and having a phase—phase voltage of approximately 3500.

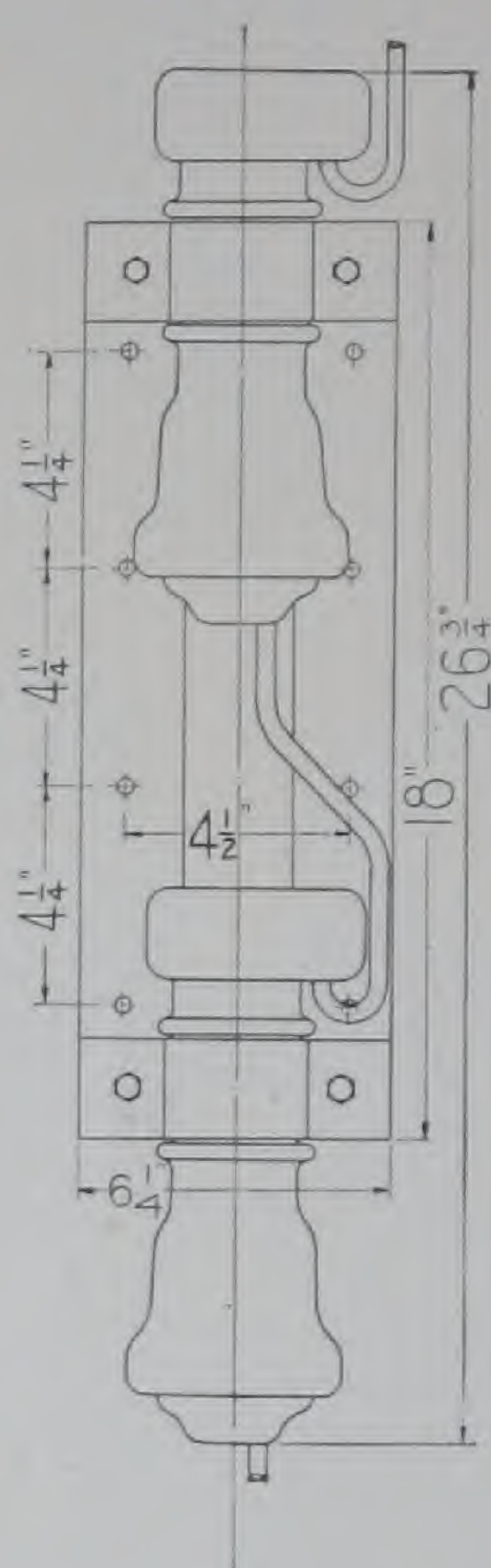
Complete listing of ground fittings is given on page 42.

List No.		Std. Pkg.	List Price
50672	Type EX, form 0, arrester, 350-1200 volts .....	12	\$8.25
50632	Type EX, form 1, arrester, 1200-2500 volts .....	12	10.50
50633	Type EX, form 2, arrester, 2500-3500 volts .....	6	13.00
50636	Type EX, form 3, arrester, 2500-volt, 3-phase Y .....	12	13.00

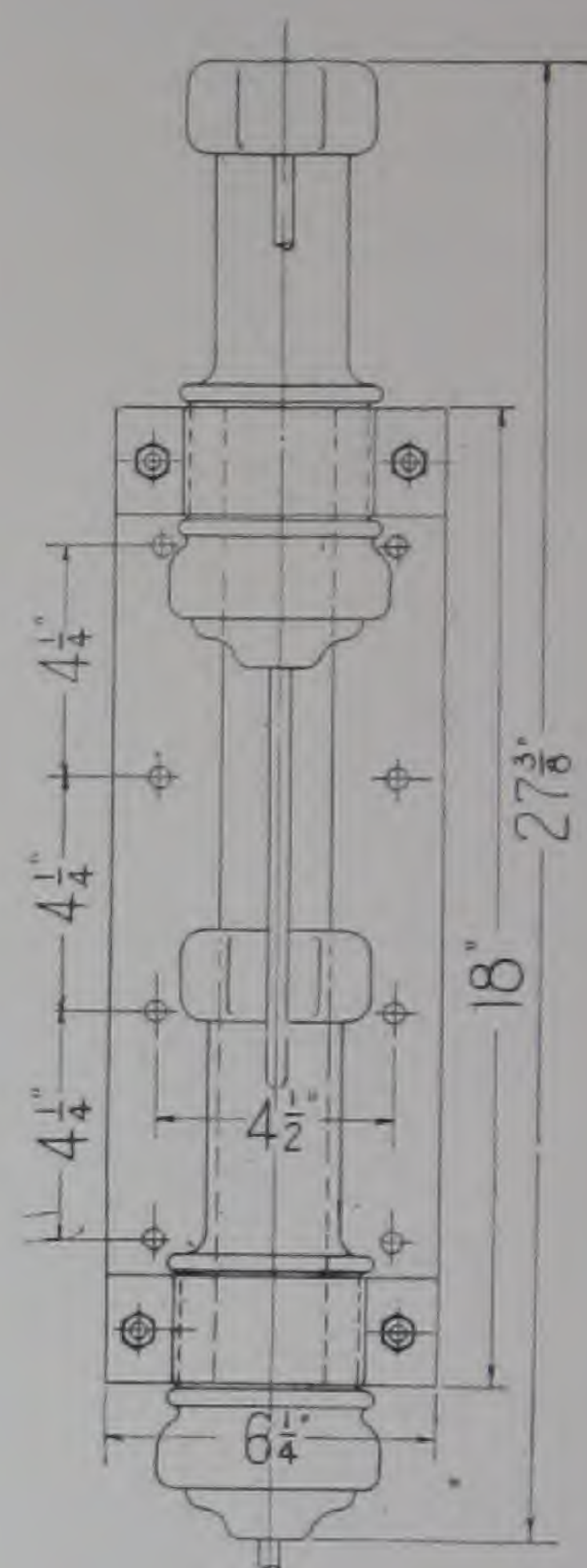


## KEYSTONE LIGHTNING ARRESTERS

Expulsion Type—3500 to 7500 Volts, A. C.



No. 50640



No. 50671

Keystone expulsion type lightning arresters, forms 4 and C-6, cover a range from 3500 to 7500 volts; this includes single phase, four-wire two phase, three-wire two phase, either grounded or ungrounded, three-phase Delta and three and four-wire three-phase Y circuits, either grounded or ungrounded, the phase—phase voltage of any classes running from 3500 to 7500 volts.

Form 4 arresters consist of two of the form 1 arresters connected in series and mounted on a substantial steel supporting frame by which they may be attached to cross arm or other supporting means.

Form C-6 arresters consist of two form C-2 arresters connected in series and mounted in the same manner.

These arresters are entirely self-contained and require no housing when installed in exposed positions. They are regularly provided with line and ground leads of No. 6 B&S seven-strand cable, 12 inches long.

Diagram shows bolt hole spacings for supporting frames.

Average weight is 23 pounds.

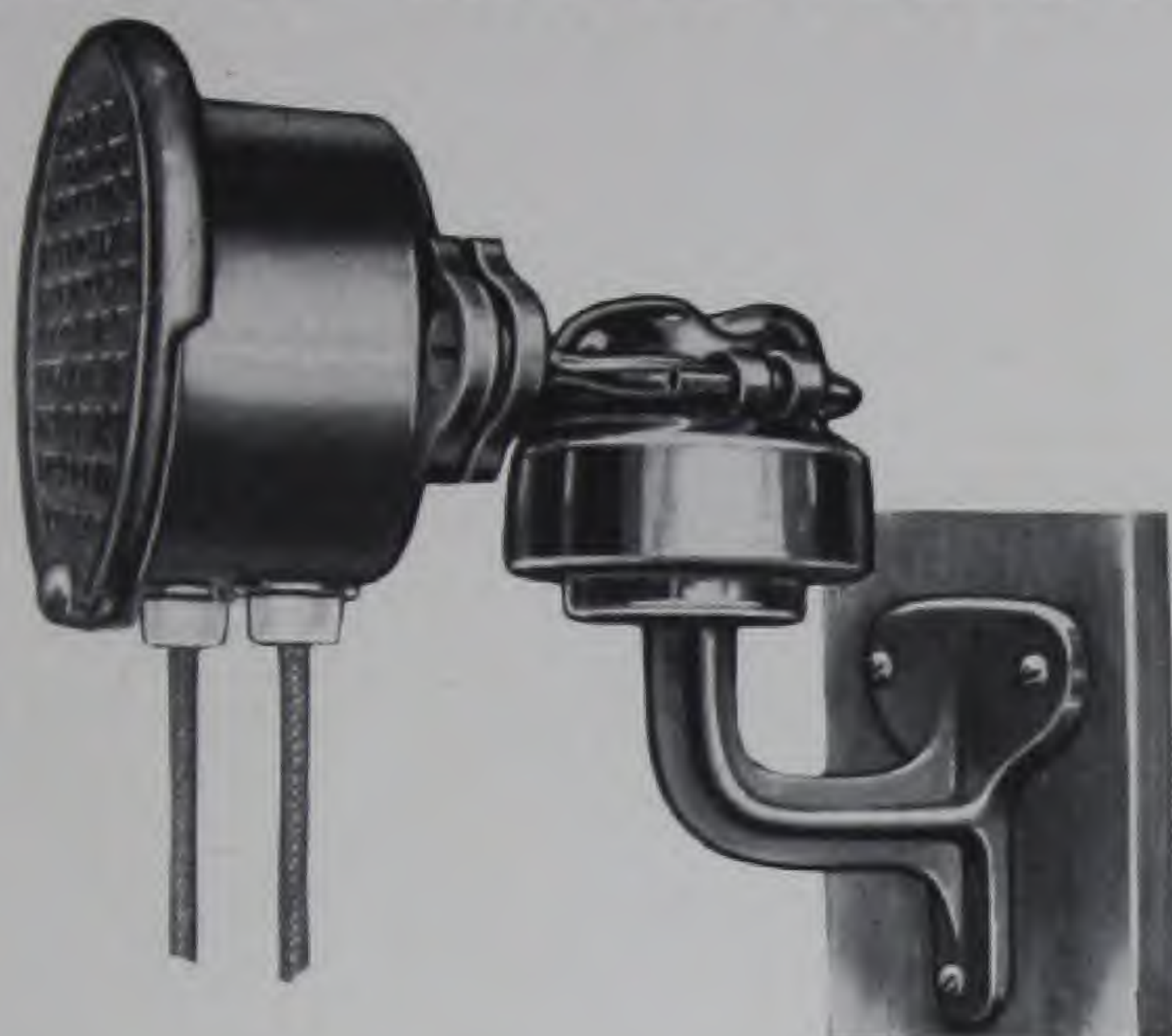
Suitable ground fittings are listed on page 42.

List No.		Std. Pkg.	List Price
50640	Type EX, form 4, arresters, 3500-5000 volts, A. C.	6	\$23.00
50671	Type EX, form C-6, arresters, 5000-7500 volts, A. C.	3	28.00



## KEYSTONE LIGHTNING ARRESTERS

Type TS Series 5000 Volts A. C.



The type TS lightning arrester illustrated above finds wide application in the protection of apparatus installed on series A. C. circuits, notably large and important series incandescent bulbs, arc lamps, and particularly small series transformers utilized to feed a standard series bulb from the low tension secondary; this latter practice being used quite generally in operating flood light projectors from series circuits for protective and other purposes.

Lightning protection on a series circuit differs somewhat from that encountered on a multiple circuit in that whenever lightning is present on the circuit it is manifested by excessive voltage not only between line and ground, but also between the terminals of apparatus connected in the circuit. To care for line-ground protection standard Garton-Daniels Lightning Arresters rated for open-circuit voltage of the generator or transformer feeding the circuit should be used. The type TS arrester should be shunted around the series apparatus, thereby affording a by-pass for the lightning around each piece of apparatus, later to be conducted to earth by the line-ground arresters.

The arrester construction consists of two heavily beaded brass discs, separated far enough by a high resistance block to allow an air gap of  $1/50$  inch between the discs. This interior, suitably assembled with mica, porcelain, etc., is mounted in a well made iron box as shown.

Light static charges find a path around the protected apparatus through the high resistance block separating the discs. Heavier discharges pass across the small air gap. Since the voltage across any individual piece of apparatus is low, generally not exceeding 70 or 80 volts, there is no tendency for the dynamic current following a discharge to maintain a flow between the electrodes, it being cut off by their arc-extinguishing properties at the end of the first half cycle of the voltage wave.

*Type TS arresters should never be connected between any part of a series circuit and ground, they being adapted only for shunting around individual pieces of apparatus installed in the series circuit. For line-ground protection standard Garton-Daniels or Expulsion Lightning Arresters should be employed.*

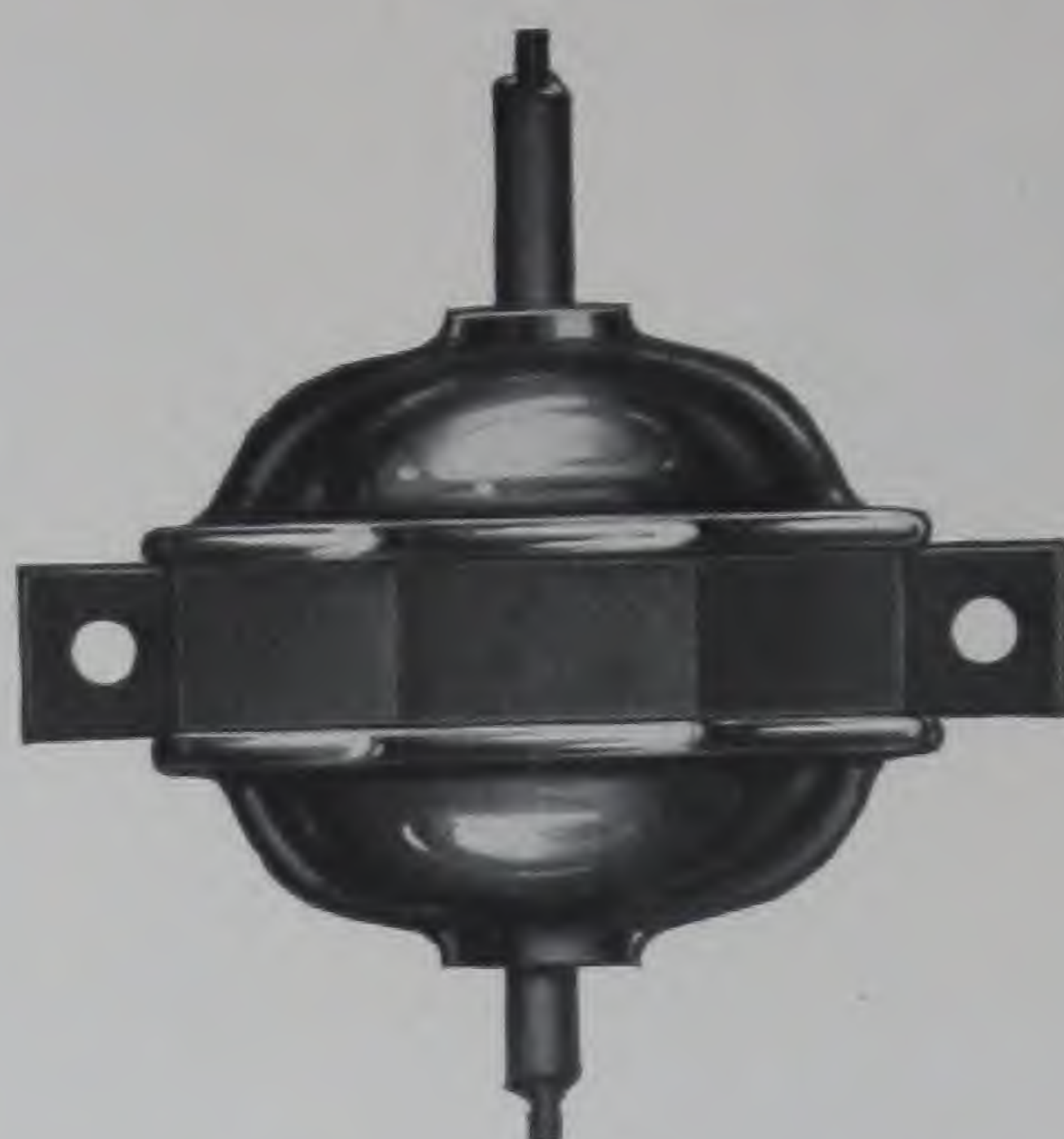
They are to be used on series circuits fed by generators or transformers, the open circuit voltage of which does not exceed 5000, and are to be shunted around series apparatus the voltage drop around which does not exceed 150 volts.

List No.		Std. Pkg.	List Price
50670	Type TS alternating current lightning arrester .....	12	\$8.30



## KEYSTONE LIGHTNING ARRESTERS

## Types N and NS Neutral Arresters



For Cross-Arm Mounting



For Line Suspension

Types N and NS arresters are designed for protecting the neutral wire of transformers installed on grounded neutral circuits, where the neutral wire is grounded only at power or sub-station, and not dead grounded at the transformer installation.

They are of the self-contained type, consisting of non-arcing metal electrodes separated by a small air gap, the whole being enclosed in a glazed porcelain body. The type N arrester is supplied with an iron band which slips over the arrester body, so allowing same to be attached to the cross arm or other supporting means. The type N S arrester is designed to be hung directly from the line wire, no other means of support being required. In both types, line lead enters the top of the arrester, ground lead leaving the bottom; both leads are securely cemented into the arrester, and as an added precaution against water leaking in through these seals, a metallic rain shield is attached to the upper or line lead inside the arrester, so effectively shielding the gap and preventing short-circuits from leaks.

These arresters are cheap, simple, durable, of high efficiency, easy to install and inspect; maximum height of either type is  $2\frac{5}{8}$ " ; width,  $3\frac{1}{4}$ ". Iron strap for supporting type N arrester has two  $\frac{9}{32}$ " holes spaced on  $3\frac{3}{4}$ " centers. Both arresters are supplied with line and ground leads of No. 12 B&S gauge cable, 12 inches long.

Ground fittings are listed on page 42.

List No.		Std. Pkg.	List Price
50642	Type N Neutral Arrester for Cross Arm Mounting.....	24	\$2.00
50643	Type NS Neutral Arrester for Line Suspension.....	24	1.90



## GARTON-DANIELS LIGHTNING ARRESTERS



The many types of Garton-Daniels lightning arresters, as listed on the following pages, are of the circuit-breaker type. They have remained unchanged in principle for over 29 years and have rendered extraordinary service to thousands of operating companies. They are standard equipment on the lines of many companies and are used in conjunction with Expulsion Type lightning arresters where it is desired to carry out the method of protection to transformers as outlined in the forepart of this bulletin. Garton-Daniels lightning arresters when used in conjunction with Expulsion Type arresters should be installed at large transformer installations, installations where the continuity of service is of greatest importance. Station apparatus should always be protected with Garton-Daniels arresters. For years they have proven their efficiency and reliability in protecting electrical apparatus under the most severe conditions.

All Garton-Daniels lightning arresters are sold with the following guarantee.

### Guarantee

All Garton-Daniels Alternating Current Lightning Arresters sold by this Company are Guaranteed Unconditionally for one year from date of sale. If for any reason whatsoever they prove unsatisfactory during that time, they may be returned to the Electric Service Supplies Company's Factory, Seventeenth and Cambria Streets, Philadelphia, where they will be either repaired or replaced free of charge, or the entire purchase price refunded, at the discretion of customer.

### Guarantee

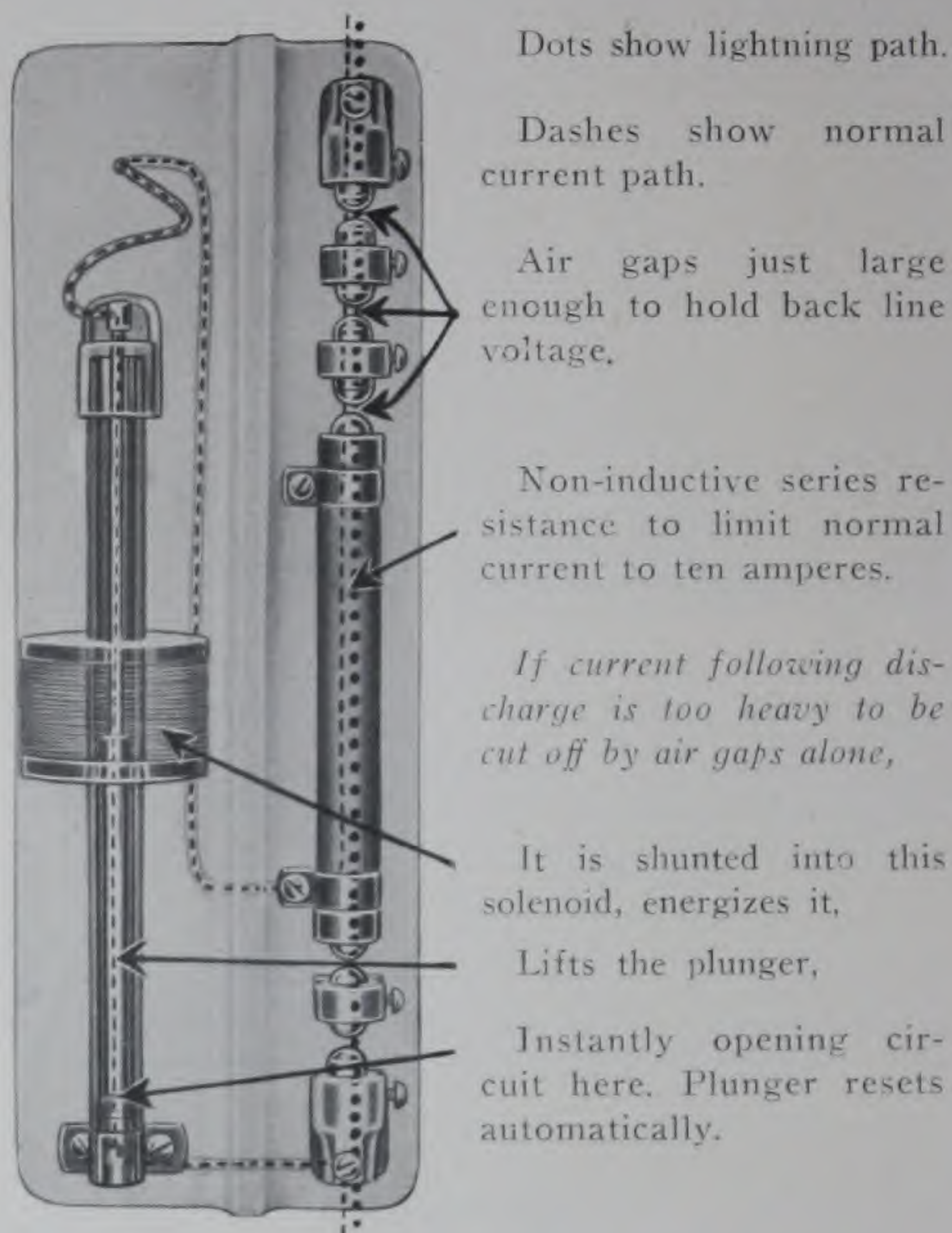
All Direct Current Lightning Arresters sold by this Company are guaranteed for one year's service. Under this guarantee any that are damaged by either the lightning or the normal current within one year of date of sale, will be repaired or replaced, without charge, if returned to the Electric Service Supplies Company's Factory, Seventeenth and Cambria Streets, Philadelphia.

The only conditions to the above are (1) that the Arresters be installed in accord with the printed instructions sent with each shipment, and (2) that not less than five (5) Arresters to the mile of line be used in Electric Railway work (grounded circuits), or less than two (2) sets to the mile of line in Light or Power work (metallic circuit); in the latter case, Arresters on each side of the circuit at intervals of one-half mile.



## GARTON-DANIELS LIGHTNING ARRESTERS

Showing Operation of 3500 Volt A. C. Arrester



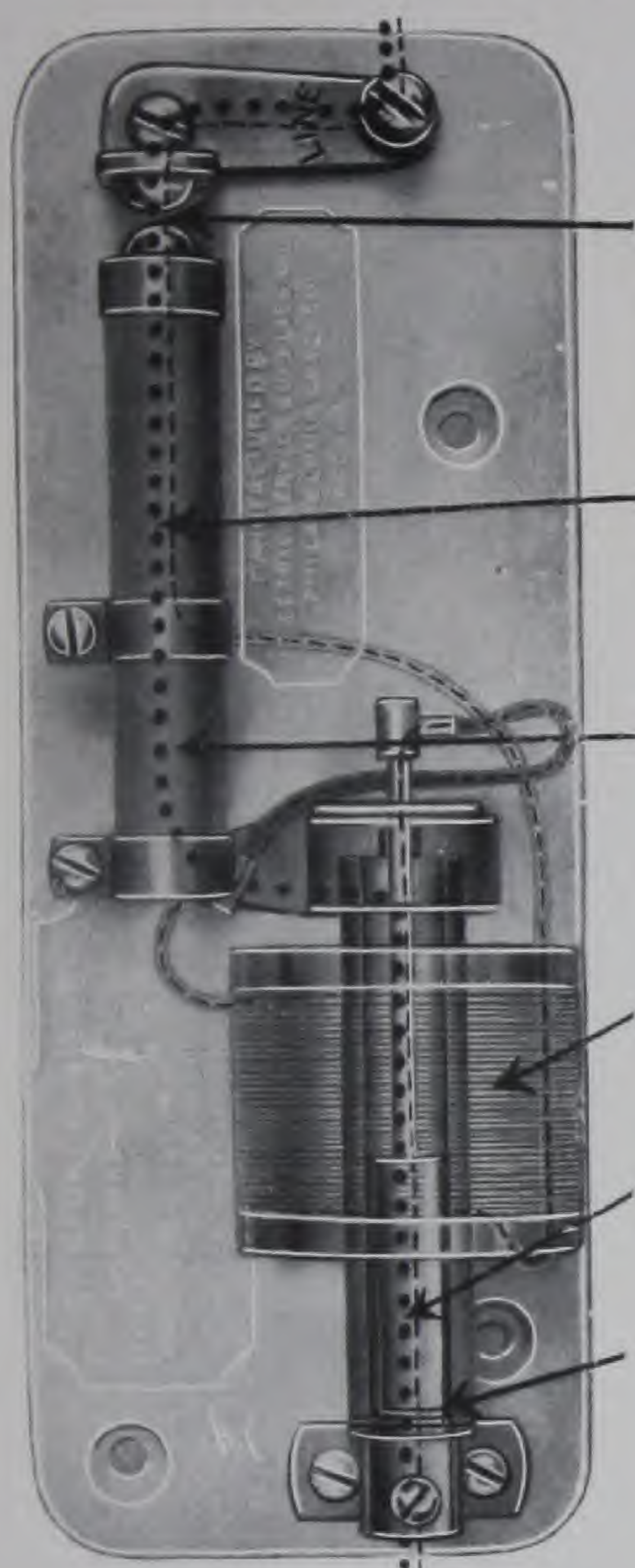
Garton-Daniels A. C. lightning arresters consist of a small air gap distance, low series resistance and an electrically operated circuit breaker.

Small air gap distance means efficient protection; low series resistance means the elimination of surges, low voltages, winking lights and other voltage disturbances; the circuit breaker means the elimination of lightning arrester grounds and short circuits on your lines.



## GARTON-DANIELS LIGHTNING ARRESTERS

### Showing Operation of 750 Volt D. C. Arrester



Dots show lightning path.

Dashes show normal current path.

Air gap just large enough to hold back normal line voltage.

Non-inductive resistance to limit normal current following discharge to 10 amperes.

Lightning path in shunt with coil. Lightning flows through this non-inductive shunt path.

Normal current is shunted into this coil, energizes it,

Lifts the plunger,

Instantly opening circuit here. Plunger resets automatically.

Operating men find in Garton-Daniels D. C. lightning arresters the same principles that are embodied in the A. C. Types—the combination of small air gap distance, low series resistance and a positive electrically operated circuit breaker.

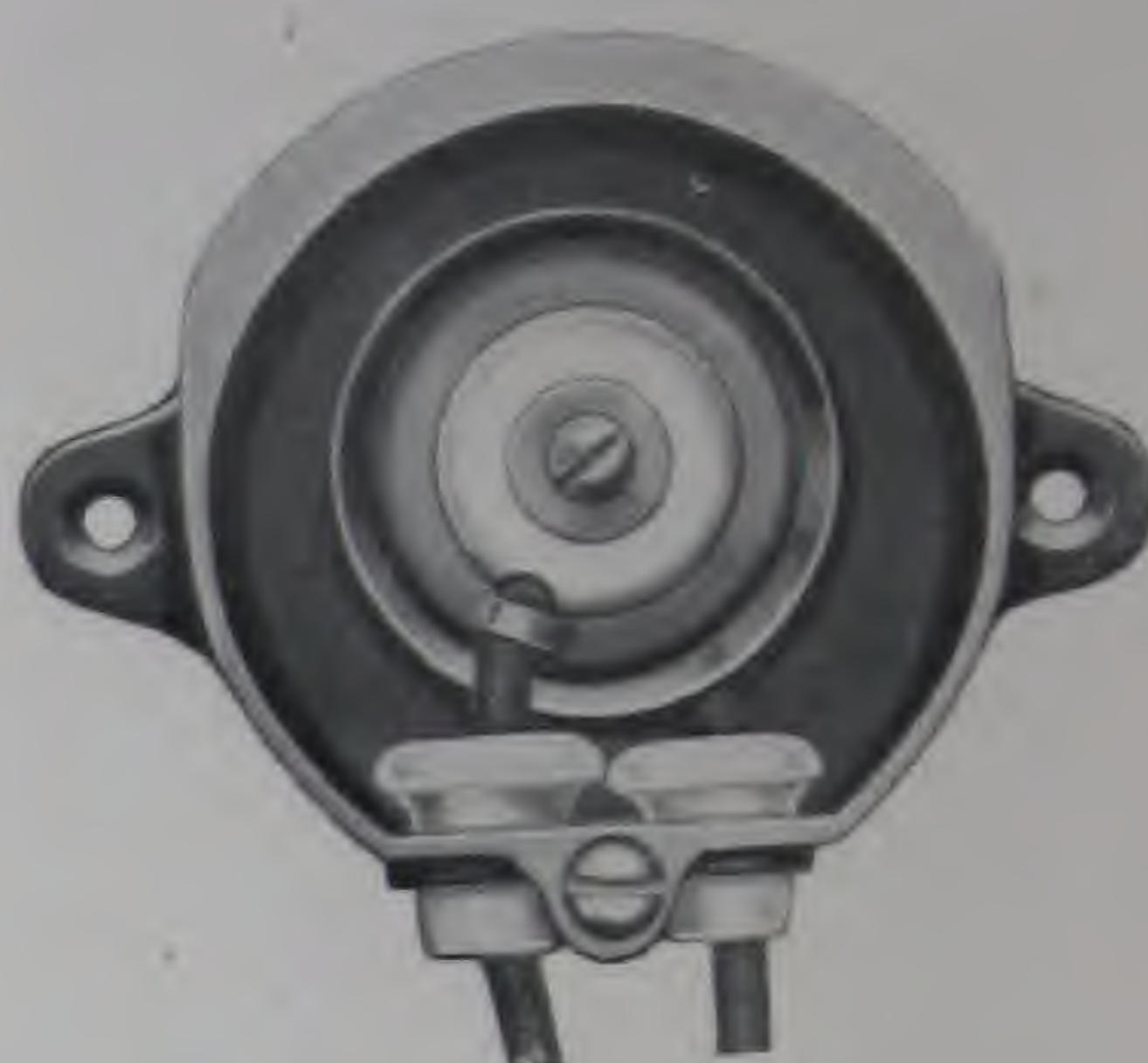
Small air gap distance means efficient protection; low series resistance means the elimination of heavy current flows to ground that otherwise would follow the lightning discharge, hence the elimination of low voltages, severe strains on the windings of the generating equipment, and other evils, the circuit breaker gives a positive cut-off of this flow to ground and so eliminates the grounding or short-circuiting of the line through the arrester, with its consequent destruction.

This circuit breaker takes all wear and burning incident to extinguishing the arc at the air gap; the air gap so remains constant; the efficiency of the arrester maintains through years of service.



## GARTON-DANIELS LIGHTNING ARRESTERS

Type T, Up to 350 Volts A. C.



Arrester with Lid Removed

Type T lightning arresters are for use on any A. C. circuits of 350 volts or less, and are particularly recommended for incandescent lighting circuits and for the protection of individual arc lamps by shunting them around the terminals.

In construction they consist simply of two heavily-beaded brass discs, separated far enough by a high resistance block to allow an air gap distance of  $1/50$  inch (.020 inch) between the discs.

The interior, suitably assembled with mica, porcelain, etc., is mounted in a well-made iron box, as shown in above illustrations.

Light static discharges find a path to earth through the high resistance block separating the discs. Heavier discharges pass across the small air gap.

For extinguishing the flow of normal current following the discharge to ground, no means other than the arc extinguishing properties of the air gap are necessary. This assures a positive cut-off of this current flow at the zero point of the generator voltage wave after the discharge has passed to ground.

Type T arresters are low-priced and will be found particularly suitable for many classes of work.

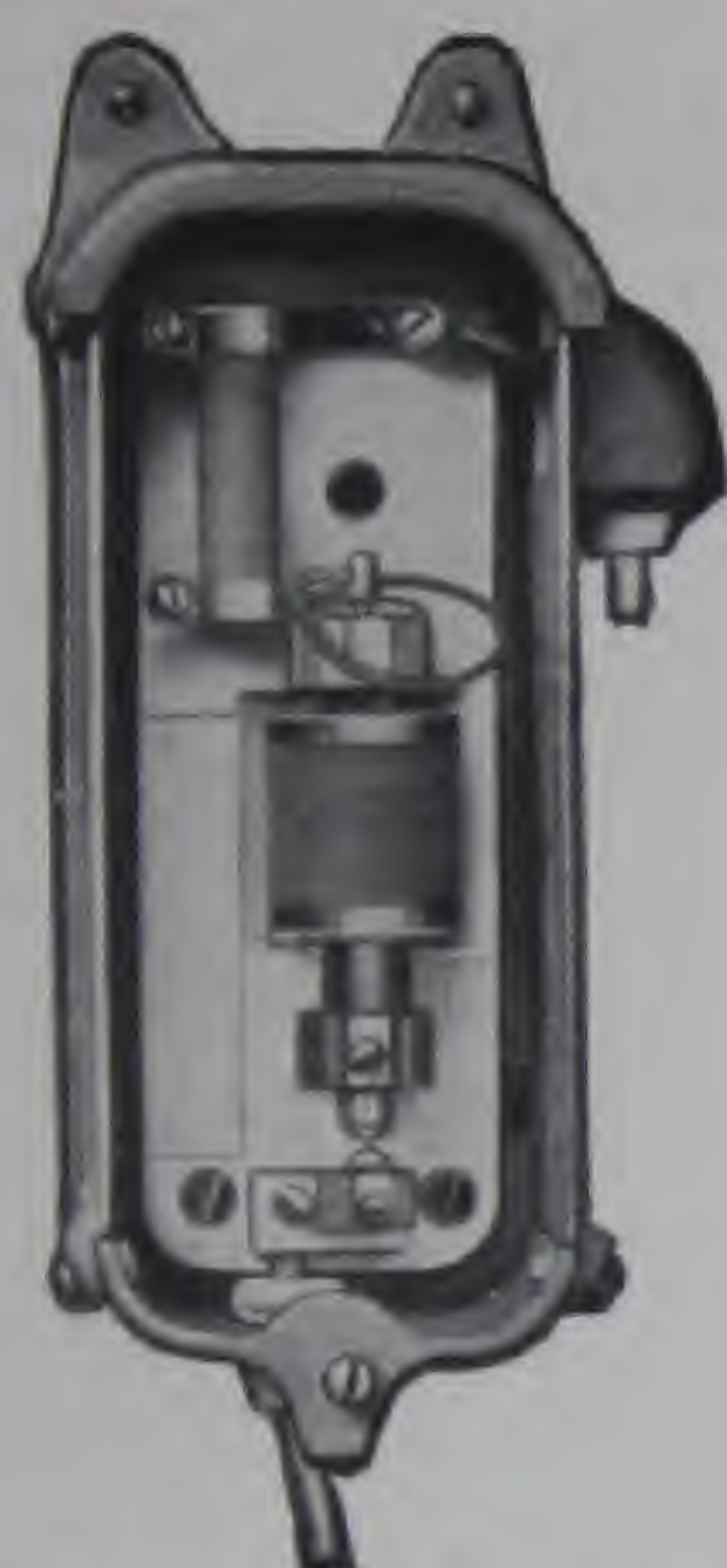
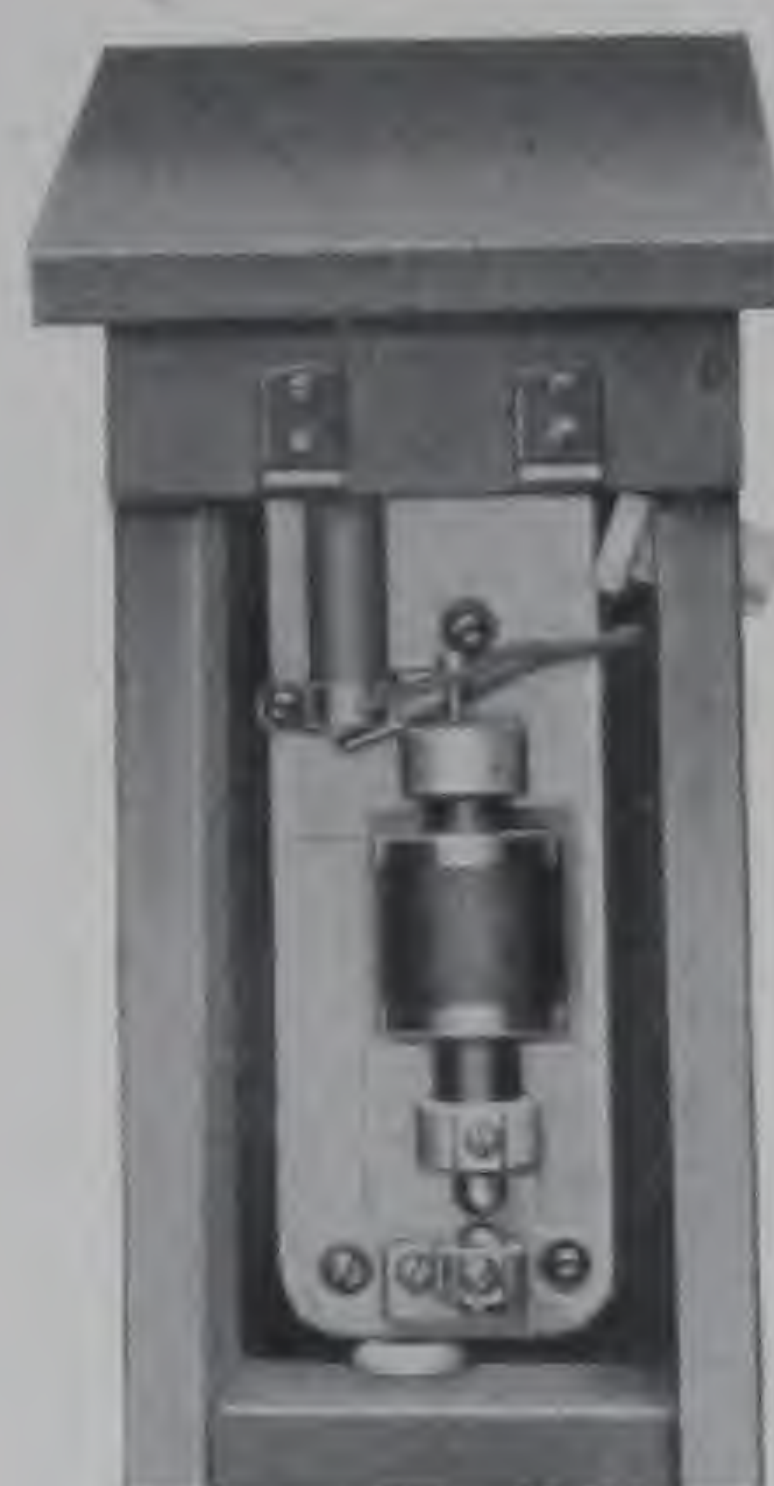
Complete listing of ground fittings is given on page 42.

List No.	Description	Dimensions	Net Weight Each	Standard Package	List Price
300	Iron Covered	$3\frac{1}{2} \times 3\frac{1}{2}$ in.	2 lbs. 10 oz.	12	\$4.00



## GARTON-DANIELS LIGHTNING ARRESTERS

Type DF, Up to 350 Volts A. C.

Pole Arrester in Iron Cover,  
Lid RemovedPole Arrester in Wooden Cover,  
Lid Removed

Type DF Garton-Daniels lightning arresters are for the protection of A. C. circuits of 350 volts or less.

The station type arrester listed below has all metal work highly polished and lacquered, to accord with our standard practice.

The pole type arresters in wooden and iron covers, illustrated above, have a dipped metal finish, but aside from this are the same as the station type.

Both the wooden and iron covers are thoroughly weatherproof and of our standard design, fitted with insulating bushings for the leading-in wires, and the arrester carefully insulated from the cover.

The air gap distance between line and ground potential in this arrester is  $1/50$  (.020) inch.

Complete listings of ground fittings, lightning arrester hangers and ground wire disconnectors are given on pages 42 to 44 inclusive.

List No.	Description	Dimensions	Net Weight Each	Standard Package	List Price
50014	Station	$8\frac{1}{2}$ x 3 x 3 in.	$2\frac{3}{4}$ lbs.	12	\$8.50
50016	Iron Covered	$12\frac{1}{2}$ x 6 x 4 in.	$11\frac{1}{8}$ lbs.	12	11.00
50015	Wood Covered	$13\frac{1}{2}$ x 7 x 6 in.	$6\frac{3}{4}$ lbs.	12	9.50



## GARTON-DANIELS LIGHTNING ARRESTERS

Type FH, 350 to 1200 Volts A. C.



Station Type Arrester

Pole Arrester in Wooden Cover,  
Lid Removed

Type FH Garton-Daniels lightning arresters are adapted for protection of A. C. circuits of from 350 to 1200 volts.

Station type arresters are furnished assembled on porcelain bases, with highly polished and lacquered metal parts.

The pole type arresters are provided with wooden or iron covers, as desired, both of which are thoroughly waterproof and of our standard design. They are fitted with insulating bushings for the leading-in wires, and the arrester is carefully insulated from the cover.

The standard air gap distance between line and ground potential in this arrester is 1/16 inch. The non-inductive resistance averages 100 ohms.

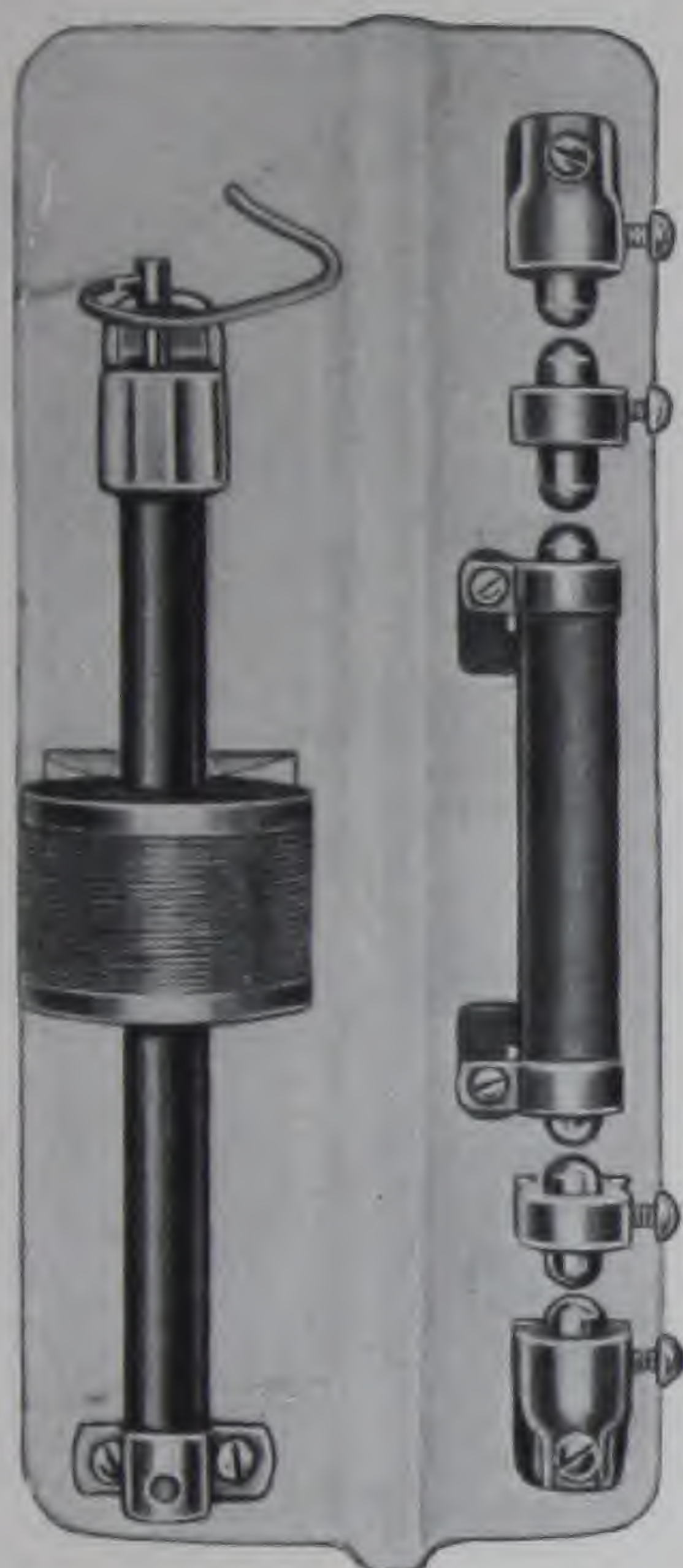
Complete listings of ground fittings, lightning arrester hangers and ground wire disconnectors are given on pages 42 to 44 inclusive.

List No.	Description	Dimensions	Net Weight Each	Standard Package	List Price
50017	Station Type	10½ x 3⅝ x 3 in.	4¼ lbs.	12	\$9.50
50018	Iron Covered	14⅞ x 6½ x 4½ in.	15¾ lbs.	12	12.00
50019	Wood Covered	14½ x 7 x 6¼ in.	8¾ lbs.	12	10.50

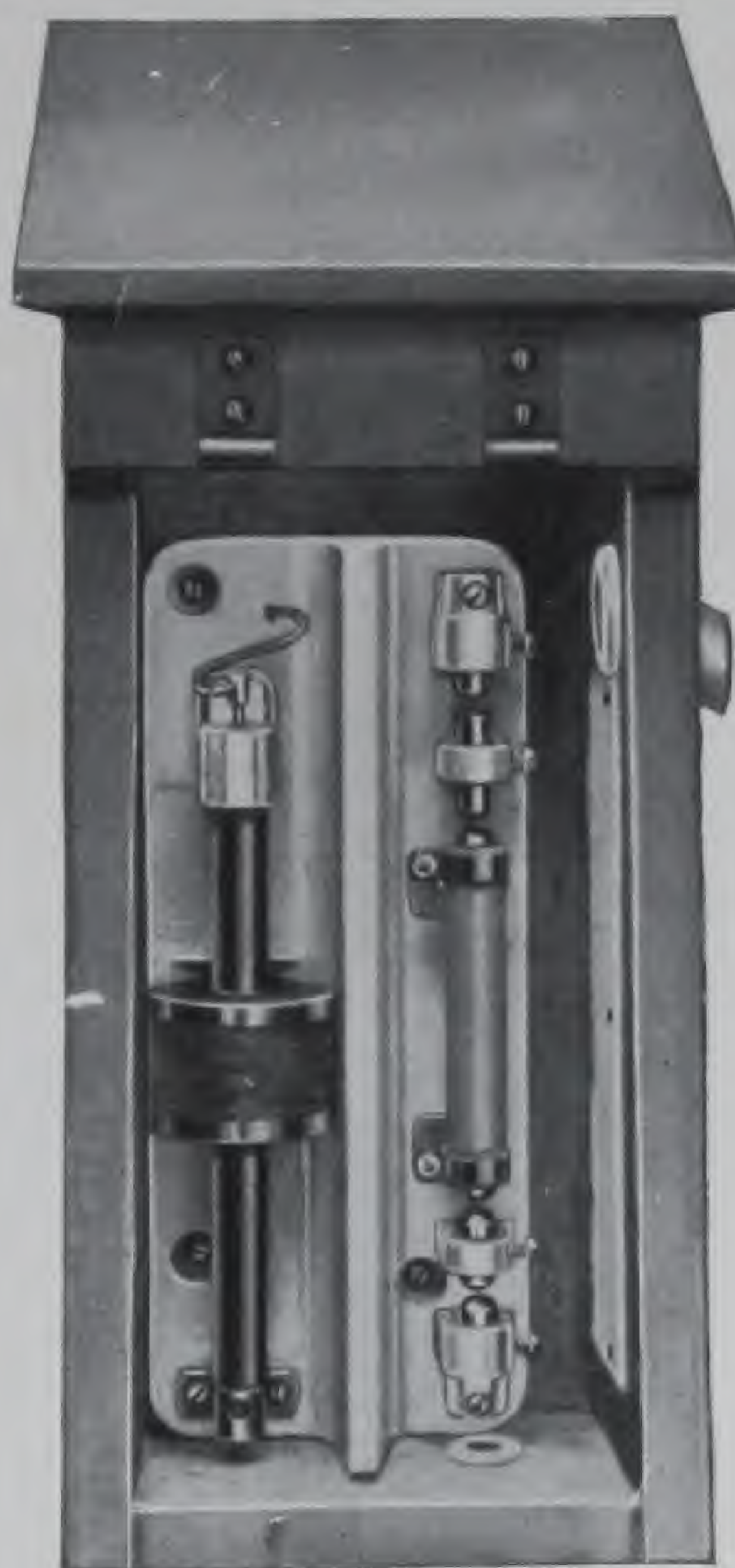


## GARTON-DANIELS LIGHTNING ARRESTERS

Type CE-2, 1200 to 2500 Volts A. C.



Station Type Arrestor

Pole Arrestor in Wooden Cover,  
Lid Removed

Type CE-2 Garton-Daniels lightning arresters are recommended for use on any circuit the voltage of which does not exceed 2,500. They are particularly recommended for use on two-phase three-wire circuits and on three-phase circuits, either delta or Y connected.

Station type arresters for this voltage are furnished with highly polished and lacquered metal work. Pole type arresters are provided with well-made wooden covers of our standard design. Iron covers are not furnished, owing to the difficulty of providing proper insulation.

Hinges are made of copper, to prevent rusting.

Heavy porcelain bushings are provided for the leading-in wires and the arresters are thoroughly insulated from the covers.

The air gap distance between line and ground potential in these arresters is  $\frac{3}{32}$  inch. The series resistance averages 225 ohms.

Complete listings of ground fittings, lightning arrester hangers and ground wire disconnectors are given on pages 42 to 44 inclusive.

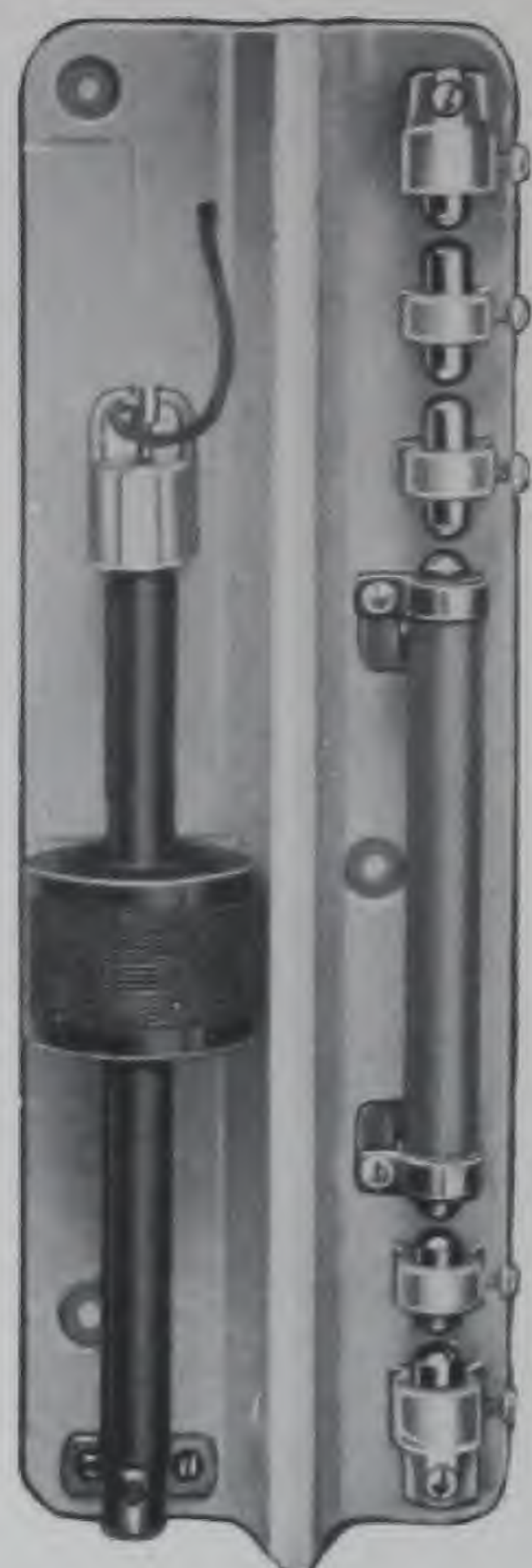
*Note.—The manufacture of our older Type CE arrester for 1200-2500 volt A. C. service has been discontinued. In future, orders for this obsolete type will be filled with type CE-2 arresters unless advices to the contrary are distinctly given on order.*

List No.	Description	Dimensions	Net Weight Each	Standard Package	List Price
50088	Station Type	11 x $4\frac{3}{4}$ x $3\frac{1}{8}$ in.	8 lbs.	12	\$11.25
50089	Wood Covered	18 x $8\frac{1}{4}$ x $6\frac{1}{4}$ in.	$13\frac{1}{2}$ lbs.	12	12.25

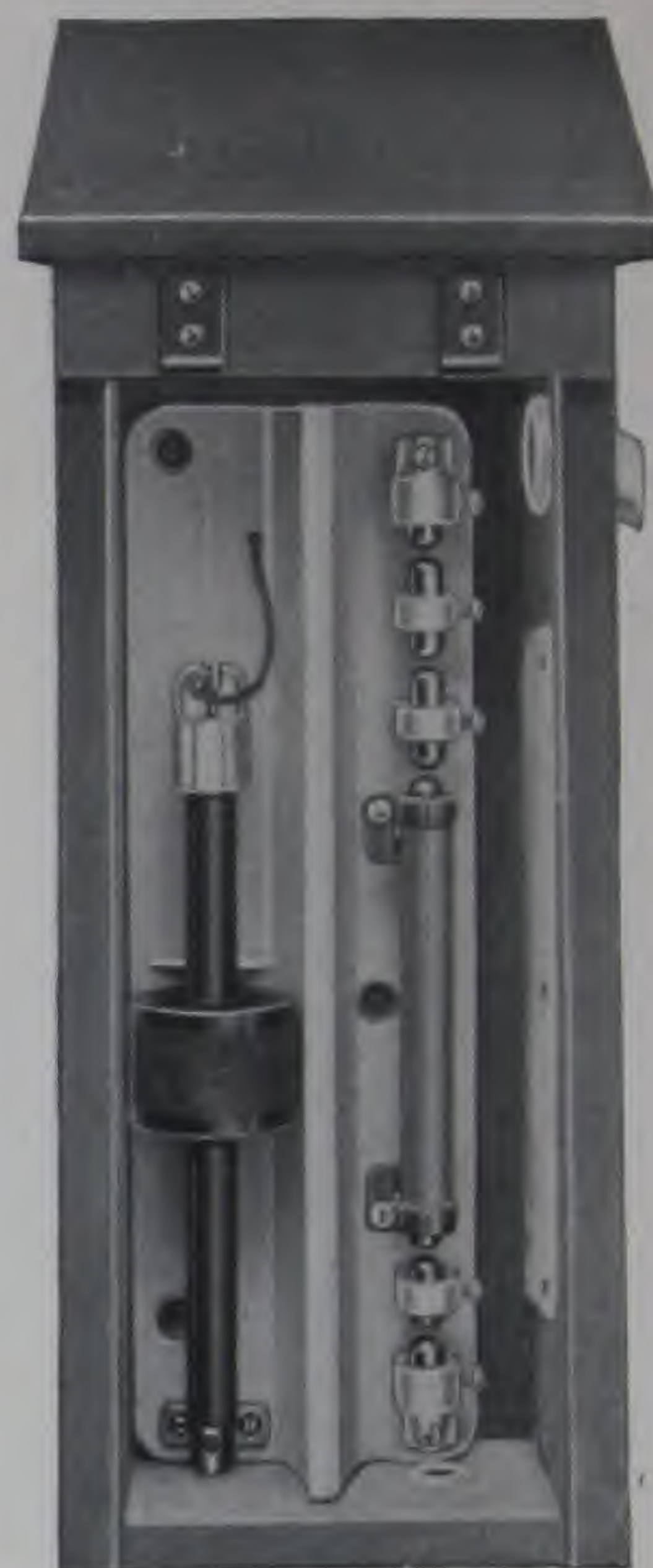


## GARTON-DANIELS LIGHTNING ARRESTERS

Type F-2-S, 2500 Volt, 3 Phase Y



Station Type Arrestor

Pole Arrestor in Wooden Cover,  
Lid Removed

Type F-2-S Garton-Daniels lightning arresters are especially designed for the protection of three-phase Y-connected grounded neutral circuits, having a voltage between phases of approximately 4,200. Many of these circuits are in existence, and much difficulty has been experienced in getting lightning arresters which would be efficient from a protective standpoint and arresters that would absolutely cut off the always heavy flow of line current following the discharge to ground.

Type F-2-S arresters are identical in construction with the type F-2 described on following page, with the exception that the air gap distance between line and ground potential is but  $\frac{1}{8}$  inch, and the series resistance averages but 225 ohms. In reality, they have practically the same discharge path characteristics as the standard type CE-2 arrester, combined with the standard F-2 circuit breaker.

These type F-2-S arresters are used in large numbers by many of the largest operating companies having circuits of this nature.

Complete listings of ground fittings, lightning arrester hangers and ground wire disconnectors are given on pages 42 to 44 inclusive.

List No.	Description	Dimensions	Net Weight Each	Standard Package	List Price
50329	Station Type	$14\frac{3}{8} \times 4\frac{3}{4} \times 3\frac{1}{8}$ in.	11½ lbs.	12	\$12.00
50330	Wood Covered	$20\frac{1}{2} \times 8\frac{1}{4} \times 6\frac{1}{4}$ in.	15¾ lbs.	12	13.25



## GARTON-DANIELS LIGHTNING ARRESTERS

Type F-2, 2500 to 3500 Volts A. C.



Station Type Arrester

Pole Arrester in Wooden Cover,  
Lid Removed

Type F-2 Garton-Daniels lightning arresters are recommended for use on any single-phase, two-phase or three-phase circuit, the voltage to ground of which does not exceed 3,500. This arrester makes therefore a single unit arrester for this voltage.

The station type and pole type arresters for this voltage are shown in the above illustrations.

The station type arrester is furnished with highly polished and lacquered metal work; the pole arrester in wooden cover has a dipped metal finish, but aside from this is the same as the station type. Due to the high voltage on which this arrester is used they are not furnished with iron covers.

The air gap distance between line and ground potential in this arrester is  $\frac{9}{16}$  inch. The series resistance averages 400 ohms.

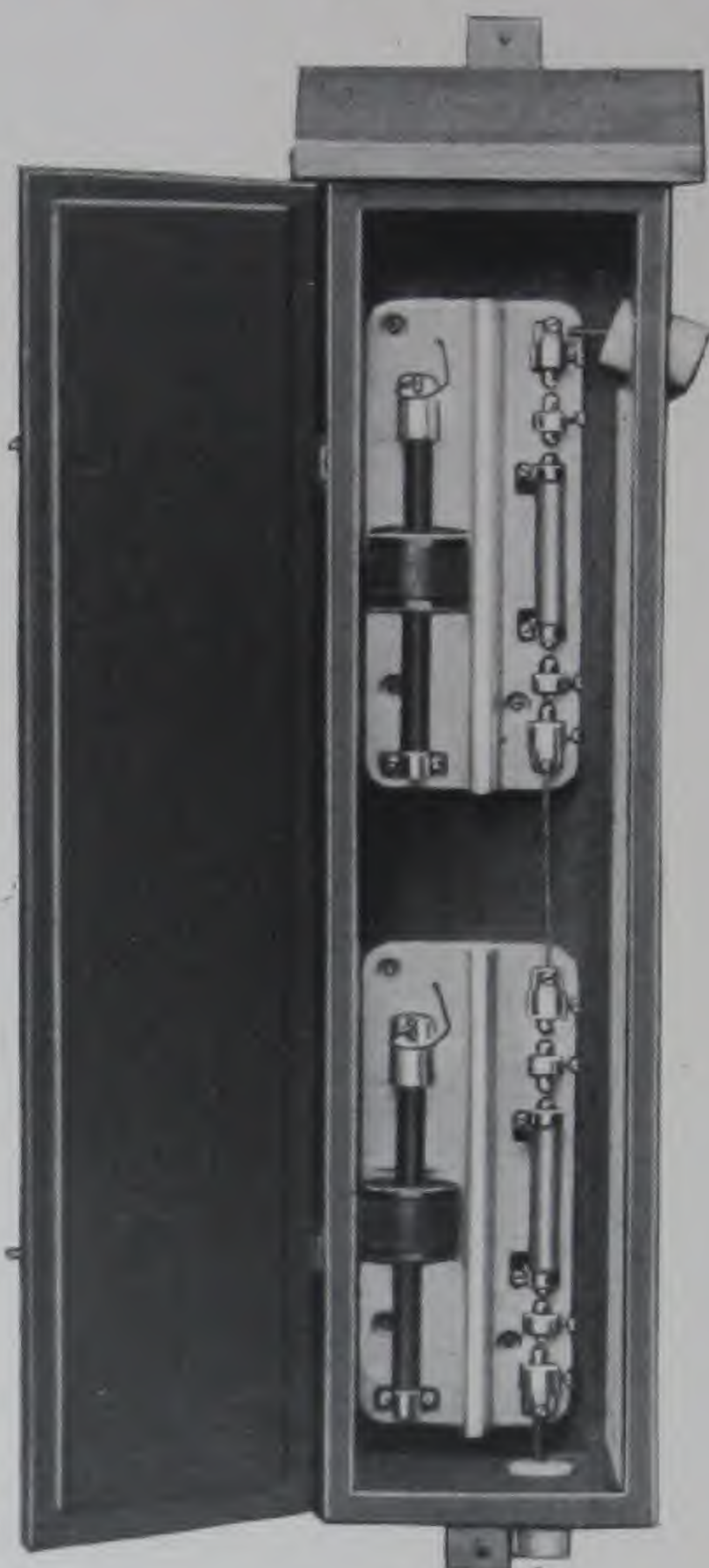
Complete listings of ground fittings, lightning arrester hangers and ground wire disconnectors are given on pages 42 to 44 inclusive.

List No.	Description	Dimensions	Net Weight Each	Standard Package	List Price
50091	Station Type	$14\frac{3}{8} \times 4\frac{3}{4} \times 3\frac{1}{8}$ in.	11½ lbs.	12	\$12.00
50092	Wood Covered	$20\frac{1}{2} \times 8\frac{1}{4} \times 6\frac{1}{4}$ in.	15¾ lbs.	12	13.25



## GARTON-DANIELS LIGHTNING ARRESTERS

Type CE-2, 3500 to 5000 Volts A. C.



Pole Arrester with door open

Type CE-2 Garton-Daniels lightning arresters, as illustrated above, are for the protection of 3500 to 5000 volt A. C. circuits. They consist of two standard type CE-2 units connected in series and provide protection for either series arc or transmission line circuits of 5000 volts or less.

These lightning arresters for station service are mounted on suitable impregnated insulating supports. For pole service they are supplied in substantially made wood covers fitted with hinged doors. Insulating bushings are supplied for leading-in wires.

The total air gap distance between line and ground potential in this type is  $\frac{3}{16}$  inch. The series resistance averages 550 ohms.

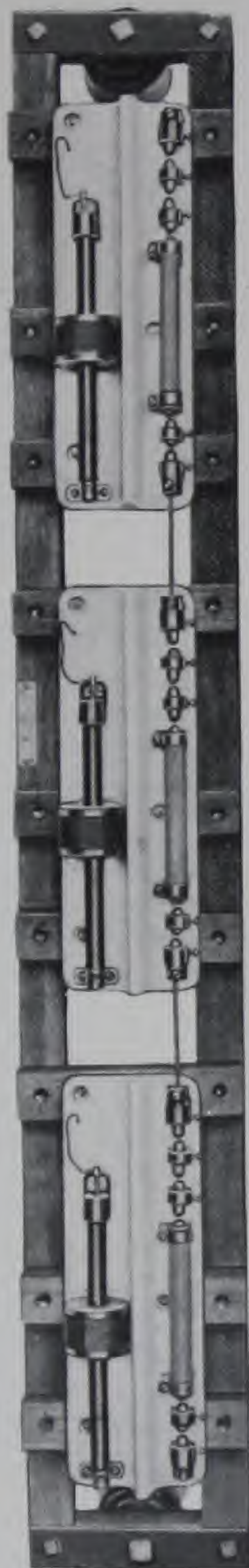
Complete listings of ground fittings and ground wire disconnectors are given on pages 42 to 44 inclusive.

List No.	Description	Dimensions	Net Weight Each	Standard Package	List Price
50093	Station	34 x 8 x $6\frac{7}{8}$ in.	26 $\frac{1}{2}$ lbs.	6	\$30.00
50094	Wood Covered	33 x 13 x $15\frac{1}{2}$ in.	49 lbs.	6	32.00



## GARTON-DANIELS LIGHTNING ARRESTERS

Type F-2-S, 6600 Volt A. C. Single Phase, Railway



Station Type Arrester

Type F-2-S Garton-Daniels lightning arresters for 6,600 volt, single phase railway service consist of three type F-2-S units, connected in series. The station arresters are mounted on impregnated insulating framework, and furnished with porcelain insulators, for supporting the whole. The pole arresters are enclosed in well-made wooden covers, with hinged door. For supporting this arrester on the pole, porcelain insulators are furnished, with angle brackets.

A special air gap adjustment of  $\frac{5}{16}$  inch is given the complete unit; the series resistance averages 825 ohms.

For single-phase electric railway work of 6,000 volts, arrester No. 50097 or 50098, listed on page 33, should be used.

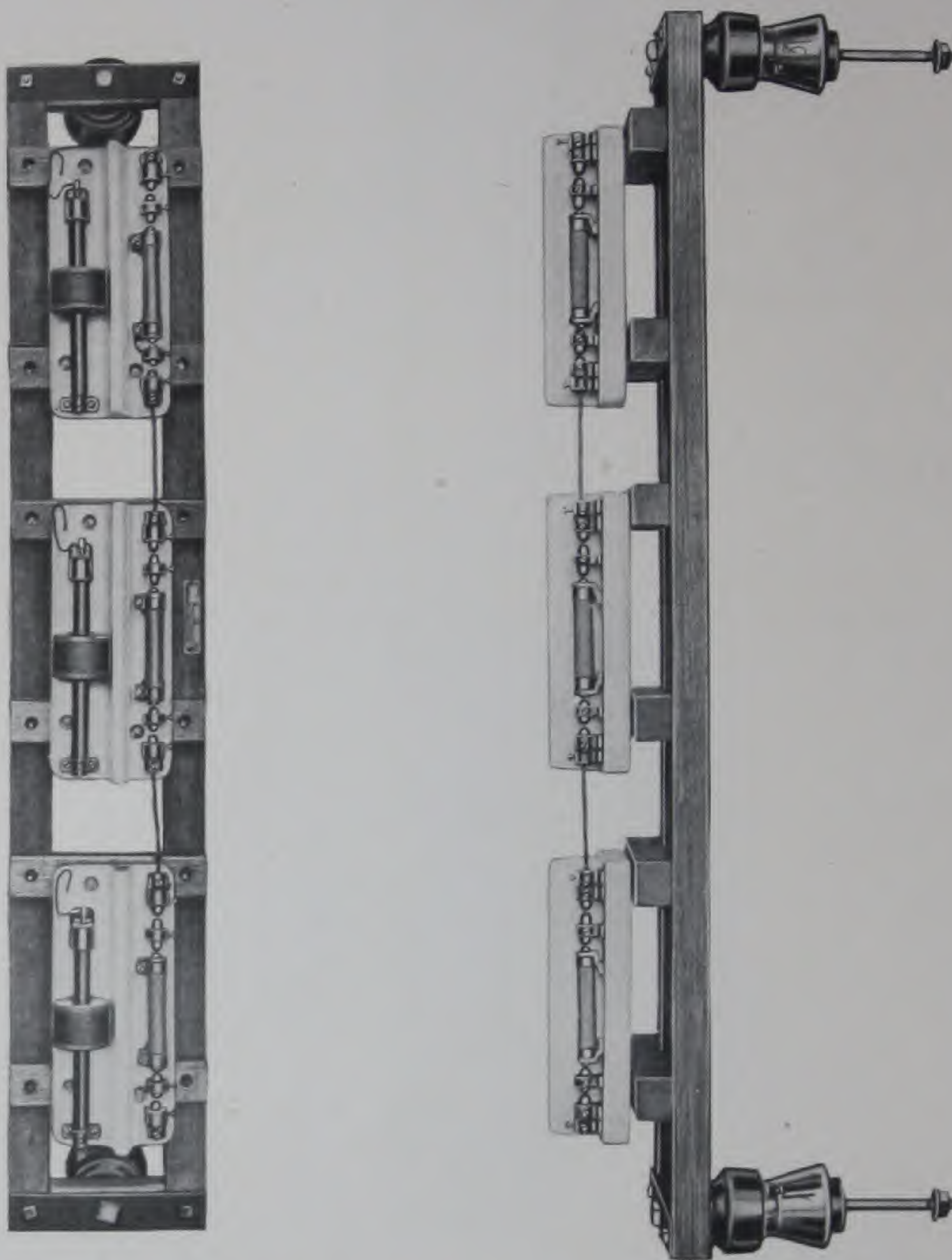
Complete listing of ground fittings is given on page 42.

List No.	Description	Dimensions	Net Weight Each	Standard Package	List Price
50442	Station	56½ x 8 x 17½ in.	58 lbs.	3	\$54.00
50443	Wood Covered	56⅝ x 13 x 15½ in.	69 lbs.	3	58.00



## GARTON-DANIELS LIGHTNING ARRESTERS

Types CE-2 and F-2, 5000 to 20,000 Volts A. C.



Garton-Daniels lightning arresters for the protection of A. C. circuits of from 5,000 to 20,000 volts consist of standard CE-2 and F-2 units connected in series. The individual units are mounted one above the other, which method of construction retains in these higher voltage types all of the advantageous features of the lower voltage types.

Arresters for station service are mounted on heavy impregnated oak frames, and are furnished complete with insulators and bolts, as illustrated, for attaching to any suitable supporting means.

Arresters for pole service are mounted in well-made wood covers. The



## GARTON-DANIELS LIGHTNING ARRESTERS

Types CE-2 and F-2, 5000 to 20,000 Volts A. C.

hinges and catches are made of copper to avoid rusting and heavy porcelain bushings are supplied for the protection of leading-in wires. The complete arrester is furnished with insulators and bolts for installation directly on pole cross-arms or other supports.

Complete details of these arresters for various voltages as well as list prices, are given in the two tables below.

Complete listings of ground fittings and ground wire disconnectors are given on pages 42 to 44 inclusive.

List No.	Voltage	Description	Consist of	Air Gap Distance	Series Resistance
50097	5,000 to 7,500	Station	3 Type CE-2	$\frac{3}{8}$ in.	825 Ohms
50098	5,000 to 7,500	Wood Covered	3 Type CE-2	$\frac{3}{8}$ in.	825 Ohms
50101	7,500 to 10,000	Station	4 Type F-2	$\frac{1}{2}$ in.	1,900 Ohms
50102	7,500 to 10,000	Wood Covered	4 Type F-2	$\frac{1}{2}$ in.	1,900 Ohms
50103	10,000 to 12,500	Station	5 Type F-2	1 in.	2,400 Ohms
50104	10,000 to 12,500	Wood Covered	5 Type F-2	1 in.	2,400 Ohms
50105	12,500 to 15,000	Station	6 Type F-2	$1\frac{1}{16}$ in.	2,800 Ohms
50106	12,500 to 15,000	Wood Covered	6 Type F-2	$1\frac{1}{16}$ in.	2,800 Ohms
50107	15,000 to 17,500	Station	7 Type F-2	$1\frac{3}{4}$ in.	3,300 Ohms
50108	17,500 to 20,000	Station	8 Type F-2	2 in.	3,800 Ohms

List No.	Voltage	Description	Dimensions in Inches	Net Weight	Std. Pkg.	List Price
50097	5,000 to 7,500	Station	48 x 3 x 17½ in.	46 lbs.	3	\$47.00
50098	5,000 to 7,500	Wood Cov'd	49 x 13 x 15½ in.	59 lbs.	3	51.00
50101	7,500 to 10,000	Station	73 x 8 x 18 in.	71 lbs.	3	72.00
50102	7,500 to 10,000	Wood Cov'd	71 x 13 x 15½ in.	93 lbs.	3	77.00
50103	10,000 to 12,500	Station	89 x 8 x 18 in.	89 lbs.	3	90.00
50104	10,000 to 12,500	Wood Cov'd	87½ x 13 x 15½ in.	116 lbs.	3	96.00
50105	12,500 to 15,000	Station	106 x 8 x 18 in.	106 lbs.	3	108.00
50106	12,500 to 15,000	Wood Cov'd	104 x 13 x 15½ in.	139 lbs.	3	115.00
50107	15,000 to 17,500	Station	122 x 8 x 18 in.	123 lbs.	3	126.00
50108	17,500 to 20,000	Station	139 x 8 x 18 in.	140 lbs.	3	144.00

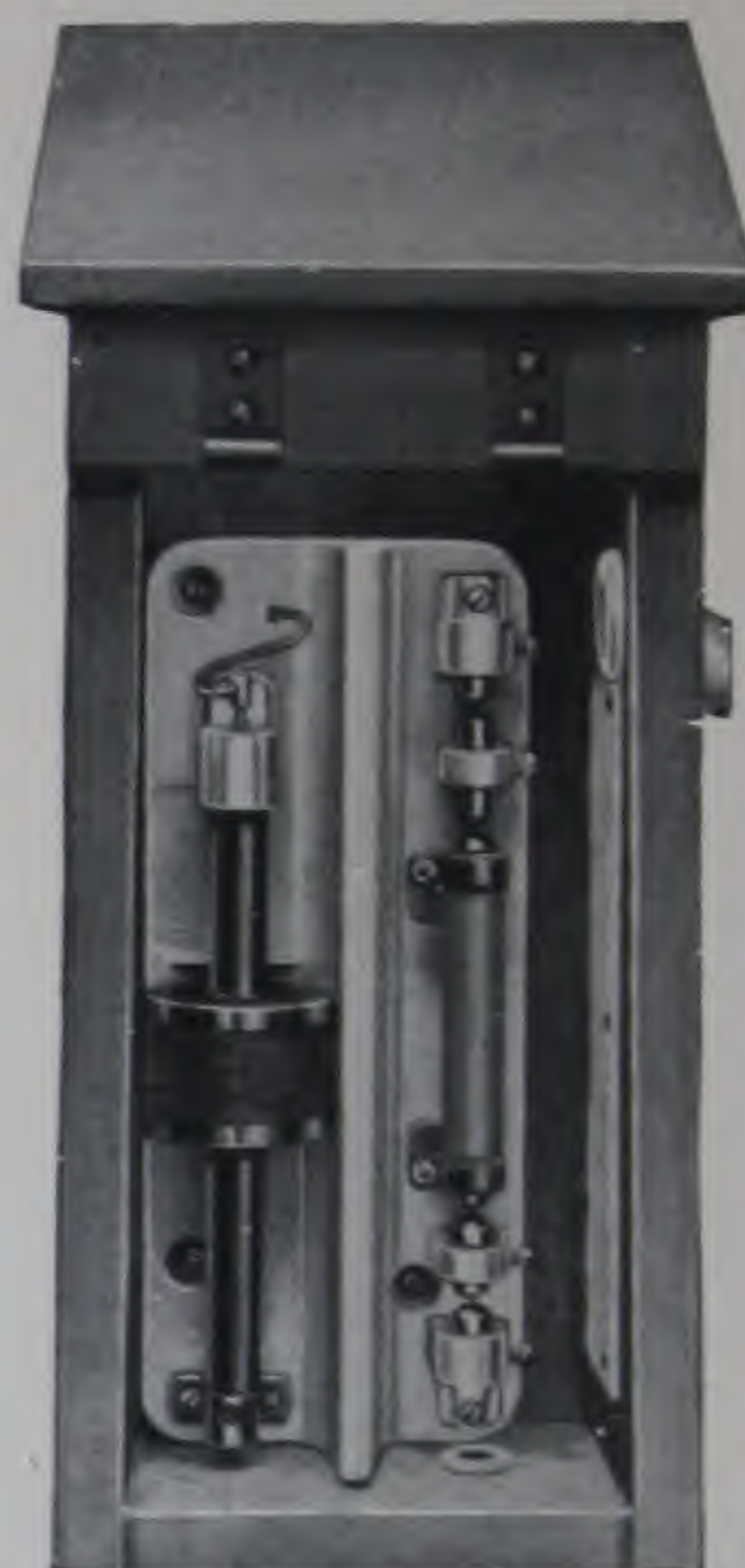


## GARTON-DANIELS LIGHTNING ARRESTERS

Arc Circuit Types, Up to 5000 Volts A. C.



3500 Volt Station Arrester



2500 Volt Pole Arrester, Wooden Cover, Lid Removed

Arc Circuit types of Garton-Daniels lightning arresters are used at the station, usually in connection with choke coils, and at intervals of about one-half mile on the line.

So installed, they afford adequate protection to both arc lamps and to generating or transforming apparatus.

A low resistance is used in these arc arresters in series with a small air gap. The resistance serves to eliminate disturbances which would otherwise occur on the circuit at the time of a discharge and assists materially in extinguishing the flow of line current following the discharge to ground.

Station arresters are furnished in standard polished and lacquered finish. Pole arresters are furnished with wood covers as illustrated.

Choke Coil No. 50042, listed on page 51, is recommended for use on arc circuits of 10 amperes or less.

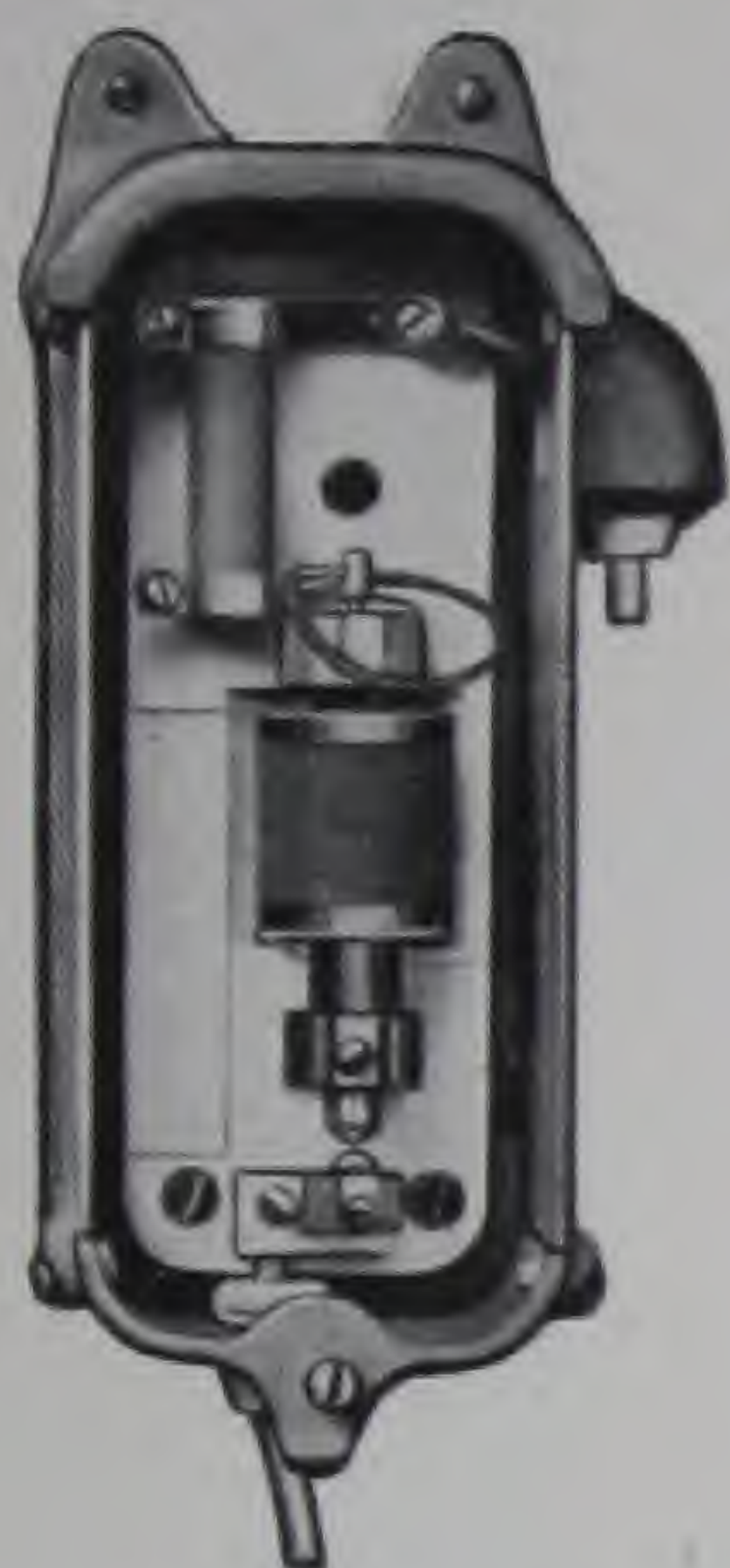
Complete listings of ground fittings, lightning arrester hangers and ground wire disconnectors are given on pages 42 to 44 inclusive.

List No.	Voltage of Circuit	Description	Net Weight Each	Standard Package	List Price
50088	Up to 2500	Station	8 lbs.	12	\$11.25
50089	Up to 2500	Wood Covered	13½ lbs.	12	12.25
50091	2500 to 3500	Station	11½ lbs.	12	12.00
50092	2500 to 3500	Wood Covered	15¾ lbs.	12	13.25
50093	3500 to 5000	Station	26½ lbs.	6	30.00
50094	3500 to 5000	Wood Covered	49 lbs.	6	32.00



## GARTON-DANIELS LIGHTNING ARRESTERS

Type DF, Up to 350 Volts D. C.

Pole Arrester with Iron Cover,  
Lid RemovedPole Arrester With Wooden Cover,  
Lid Removed

Type DF Garton-Daniels lightning arresters are for the protection of direct current circuits of 350 volts or less. They are furnished for station service and for pole service in either wood or iron weatherproof covers, as illustrated. The pole type arresters are fitted with insulating bushings and the arrester proper is completely insulated from the box cover.

The air gap distance between line and ground potential in this arrester is  $1/50$  (.020) inch.

Complete listings of ground fittings, lightning arrester hangers and ground wire disconnectors are given on pages 42 to 44 inclusive.

List No.	Description	Dimensions	Net Weight Each	Standard Package	List Price
50014	Station	8½ x 3 x 3 in.	2¾ lbs.	12	\$8.50
50016	Iron Covered	12½ x 6 x 4 in.	11⅞ lbs.	12	11.00
50015	Wood Covered	13½ x 7 x 6 in.	6¾ lbs.	12	9.50

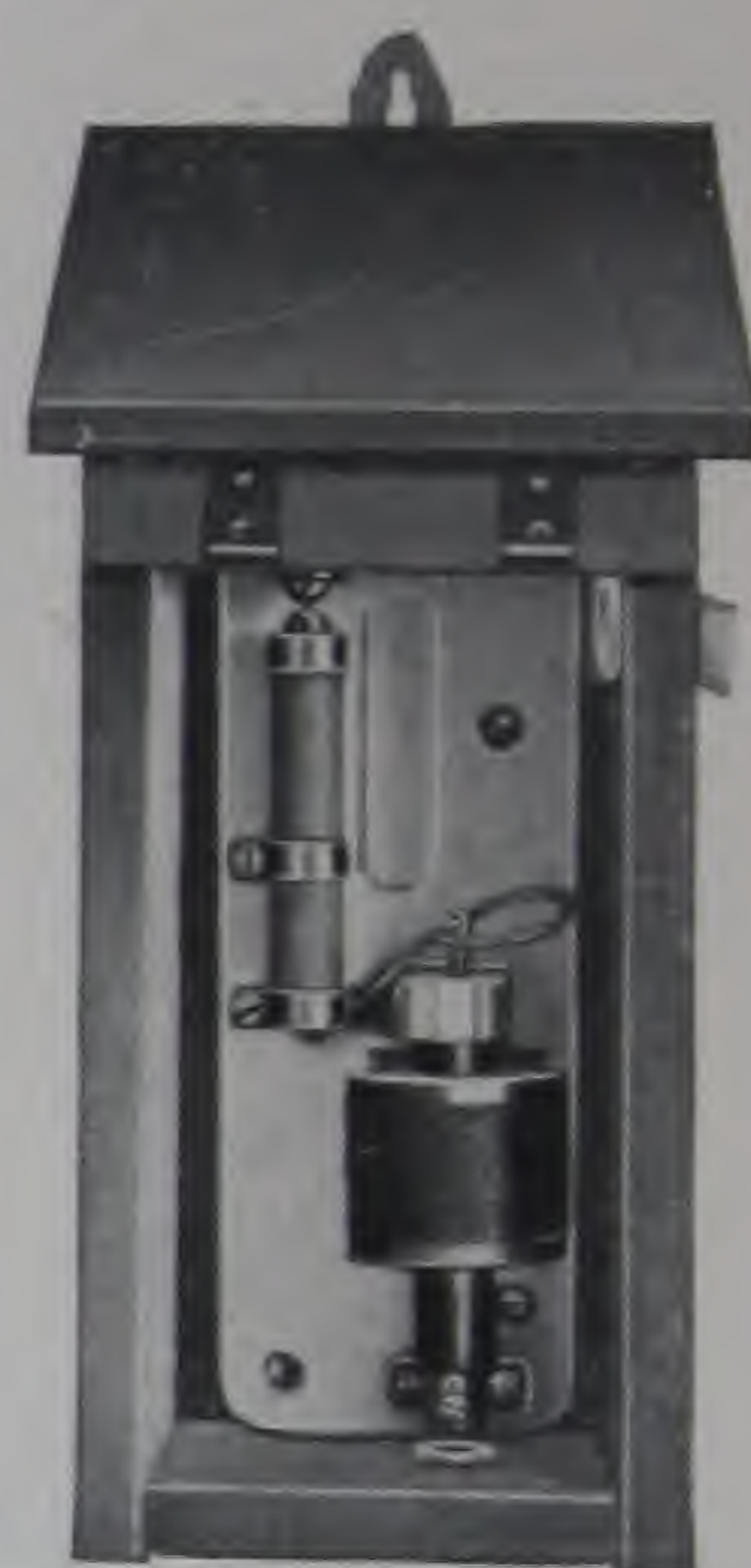
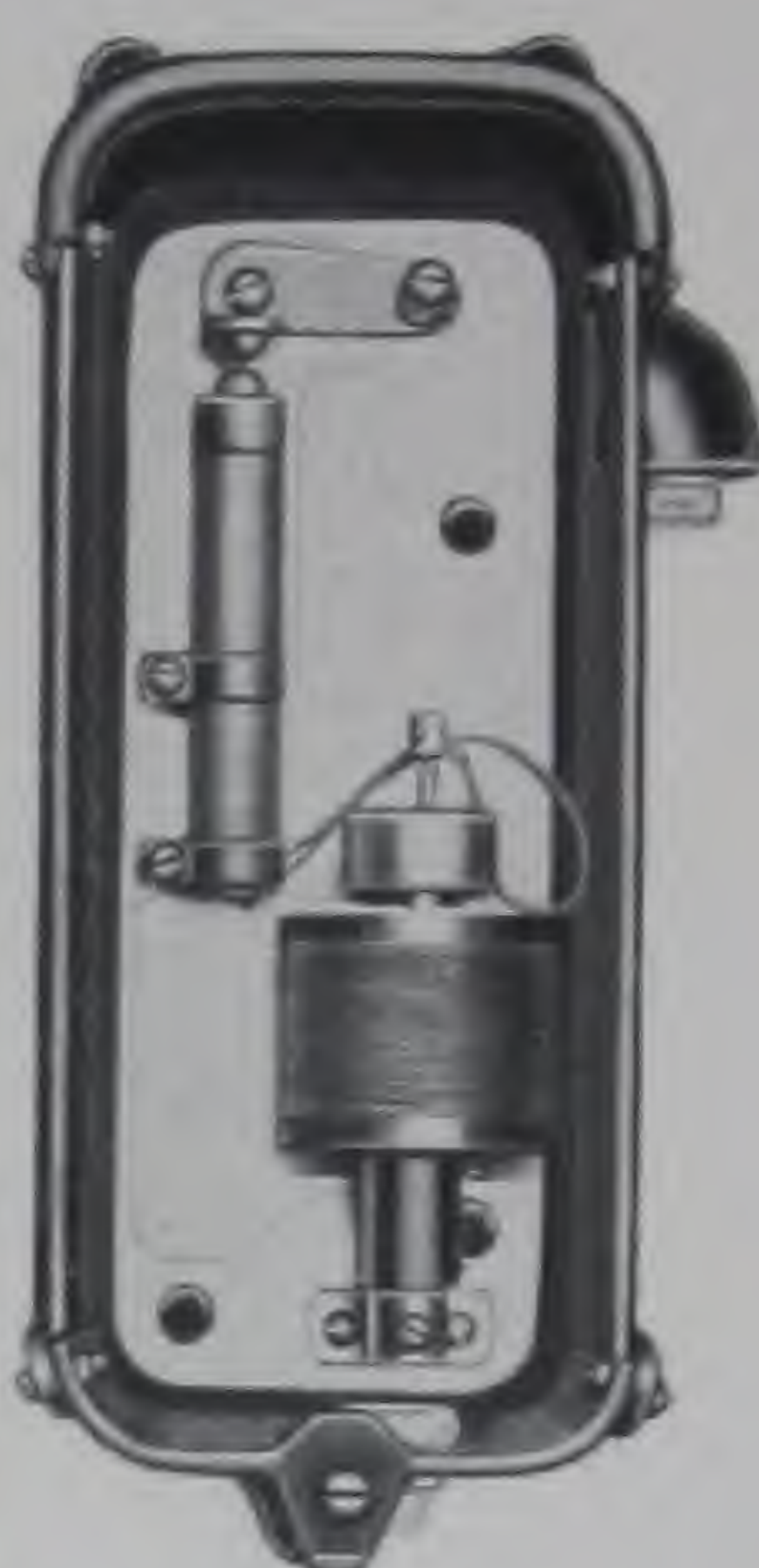


## GARTON-DANIELS LIGHTNING ARRESTERS

Type EG, 350 to 750 Volts D. C.



Pole or Car Arrester, in Iron Cover, Lid Removed



Pole Arrester, in Wooden Cover, Lid Removed

Type EG Garton-Daniels lightning arresters are adapted for protecting D. C. circuits, either ground return or complete metallic, or from 350 to 750 volts.

The discharge path for lightning has but 1/40-inch air gap and a series resistance that averages but 60 ohms. It is practically straight and offers the utmost freedom for these discharges.

All styles of arresters listed below are mounted on porcelain bases, those for station work having highly polished metal parts, while those for other purposes are furnished with weatherproof iron or wooden covers.

Arresters for car or locomotive use are supplied with flexible leading-in wires.

Complete listings of ground fittings, lightning arrester hangers and ground wire disconnectors are given on pages 42 to 44 inclusive.

## Type EG Arresters for Grounded Circuits

List No.	Type	Dimensions	Weight	Std. Pkg.	List Price
50039	Station	9 <sup>7</sup> / <sub>8</sub> x 3 <sup>5</sup> / <sub>8</sub> x 3 ins.	4 <sup>1</sup> / <sub>2</sub> lbs.	12	\$9.00
50041	Wood covered pole	14 <sup>1</sup> / <sub>2</sub> x 7 x 6 <sup>1</sup> / <sub>4</sub> ins.	8 <sup>1</sup> / <sub>2</sub> lbs.	12	10.50
50040	Iron covered pole	13 <sup>1</sup> / <sub>2</sub> x 6 <sup>1</sup> / <sub>2</sub> x 4 <sup>1</sup> / <sub>2</sub> ins.	13 <sup>1</sup> / <sub>2</sub> lbs.	12	12.00
11780	Wood covered car	14 x 7 x 6 <sup>1</sup> / <sub>4</sub> ins.	8 <sup>1</sup> / <sub>2</sub> lbs.	12	10.50
11779	Iron covered car	13 <sup>1</sup> / <sub>2</sub> x 6 <sup>1</sup> / <sub>2</sub> x 4 <sup>1</sup> / <sub>2</sub> ins.	13 <sup>1</sup> / <sub>2</sub> lbs.	12	12.00

## Type EG Arresters for Metallic Circuits

List No.	Type	Dimensions	Weight	Std. Pkg.	List Price
50193	Station	9 <sup>7</sup> / <sub>8</sub> x 3 <sup>5</sup> / <sub>8</sub> x 3 ins.	4 <sup>1</sup> / <sub>2</sub> lbs.	12	\$9.00
50194	Wood covered pole	14 <sup>1</sup> / <sub>2</sub> x 7 x 6 <sup>1</sup> / <sub>4</sub> ins.	8 <sup>1</sup> / <sub>2</sub> lbs.	12	10.50
50195	Iron covered pole	13 <sup>1</sup> / <sub>2</sub> x 6 <sup>1</sup> / <sub>2</sub> x 4 <sup>1</sup> / <sub>2</sub> ins.	13 <sup>1</sup> / <sub>2</sub> lbs.	12	12.00
50030	Wood covered car	14 x 7 x 6 <sup>1</sup> / <sub>4</sub> ins.	8 <sup>1</sup> / <sub>2</sub> lbs.	12	10.50
50031	Iron covered car	13 <sup>1</sup> / <sub>2</sub> x 6 <sup>1</sup> / <sub>2</sub> x 4 <sup>1</sup> / <sub>2</sub> ins.	13 <sup>1</sup> / <sub>2</sub> lbs.	12	12.00

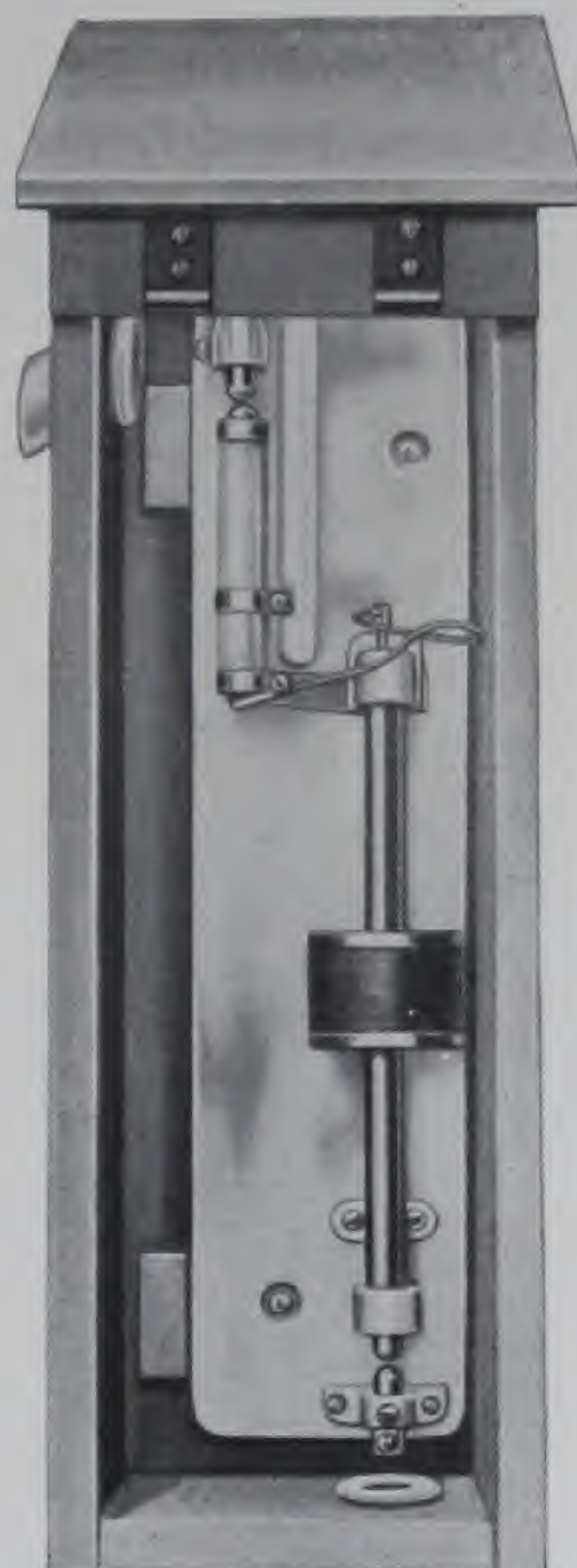


## GARTON-DANIELS LIGHTNING ARRESTERS

Type EH, 750 to 1350 Volts D. C.



Station Type Arrester



Pole Arrester with Wooden Cover

Type EH Garton-Daniels lightning arresters are for high voltage D. C. electric railway service, and combine the principles of design and operation which have proven so successful in all types of Garton-Daniels arresters.

Resistance rods are made longer, a longer break is provided in the circuit breaker for cutting off the flow of line current following the lightning discharge to ground, the arresters throughout being strongly and heavily built to suit them to the conditions under which they operate.

The air gap distance between line and ground potential in the type EH arrester is  $\frac{1}{8}$  inch; the series resistance averages 140 ohms.

These arresters are for direct current electric railway service only. For arc circuit arresters, see page 39.

Complete listings of ground fittings, lightning arrester hangers and ground wire disconnectors are given on pages 42 to 44 inclusive.

List No.	Type	Description	Dimensions	Net Weight Each	Std. Pkg.	List Price
50338	EH	Station	$19\frac{3}{8} \times 4 \times 3\frac{7}{8}$	11½ lbs.	12	\$18.00
50339	EH	Wood Car	$21\frac{1}{2} \times 10\frac{1}{2} \times 6\frac{3}{4}$	21 lbs.	12	20.00
50400	EH	Wood Covered	$25\frac{1}{4} \times 8\frac{3}{8} \times 7\frac{3}{4}$	21½ lbs.	12	20.00

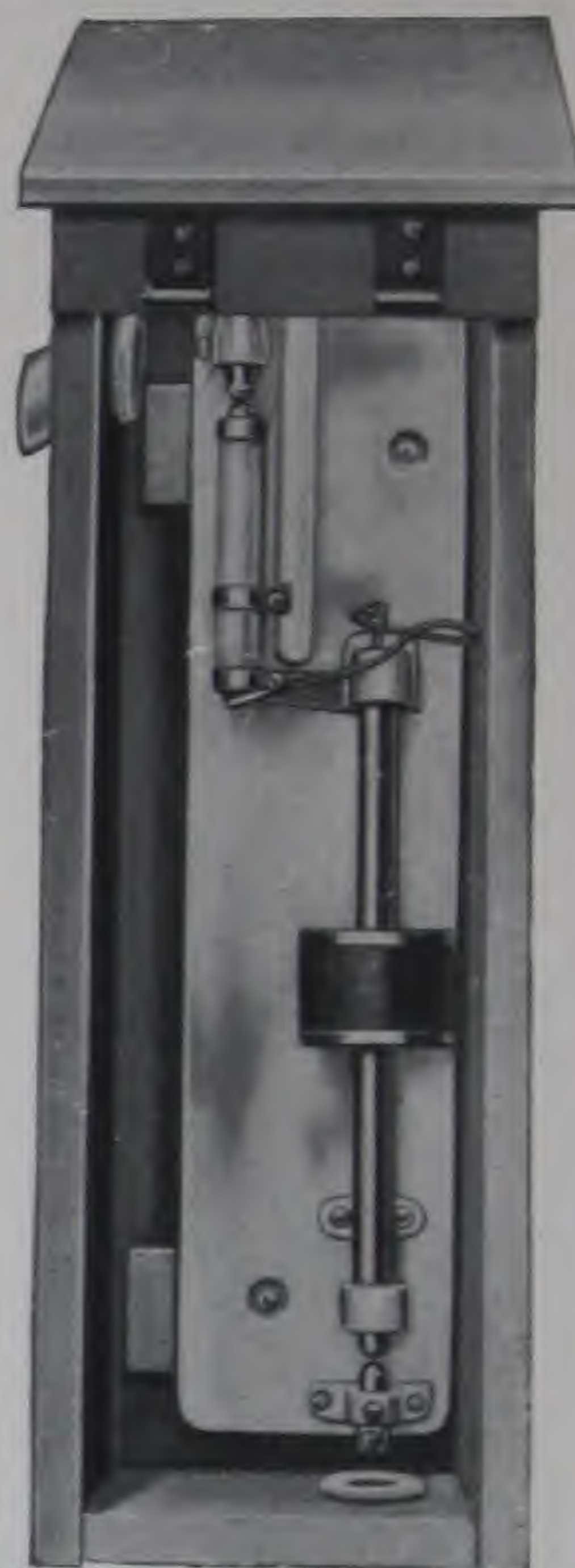


## GARTON-DANIELS LIGHTNING ARRESTERS

Types EJ and EK, 1350 to 2400 Volts D. C.



EJ Arrester, Station Type

EJ Pole Type Arrester in  
Wooden Cover

Type EJ Garton-Daniels lightning arresters are single unit arresters for D. C. electric railway service of from 1,350 to 1,800 volts.

Type EK arresters for electric railway service of from 1,800 to 2,400 volts, consist of two arrester units practically similar to type EJ, connected in series.

They are furnished only in station and wood covered types, the latter for both pole and car service, in the type EJ, and for pole service only in the type EK, both of our standard finish and construction.

The air gap distance between line and ground potential in the type EJ arrester is  $\frac{3}{8}$  inch; in the type EK,  $\frac{3}{16}$  inch; the series resistance in the former averages 225 ohms; in the latter 350 ohms.

These arresters are for direct current electric railway service only. For arc circuit arresters see page 39.

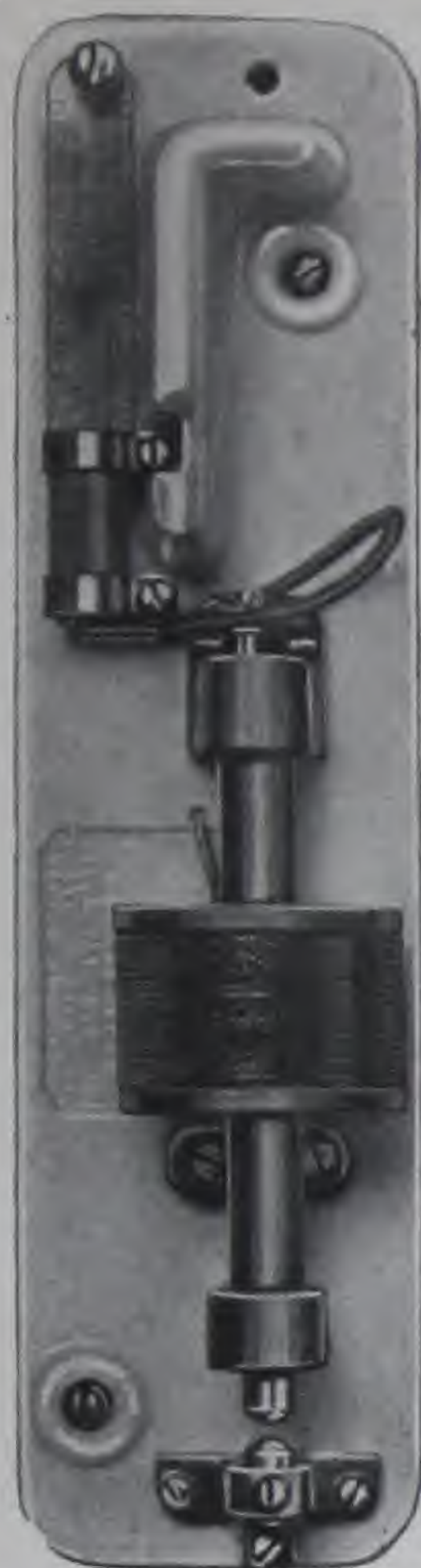
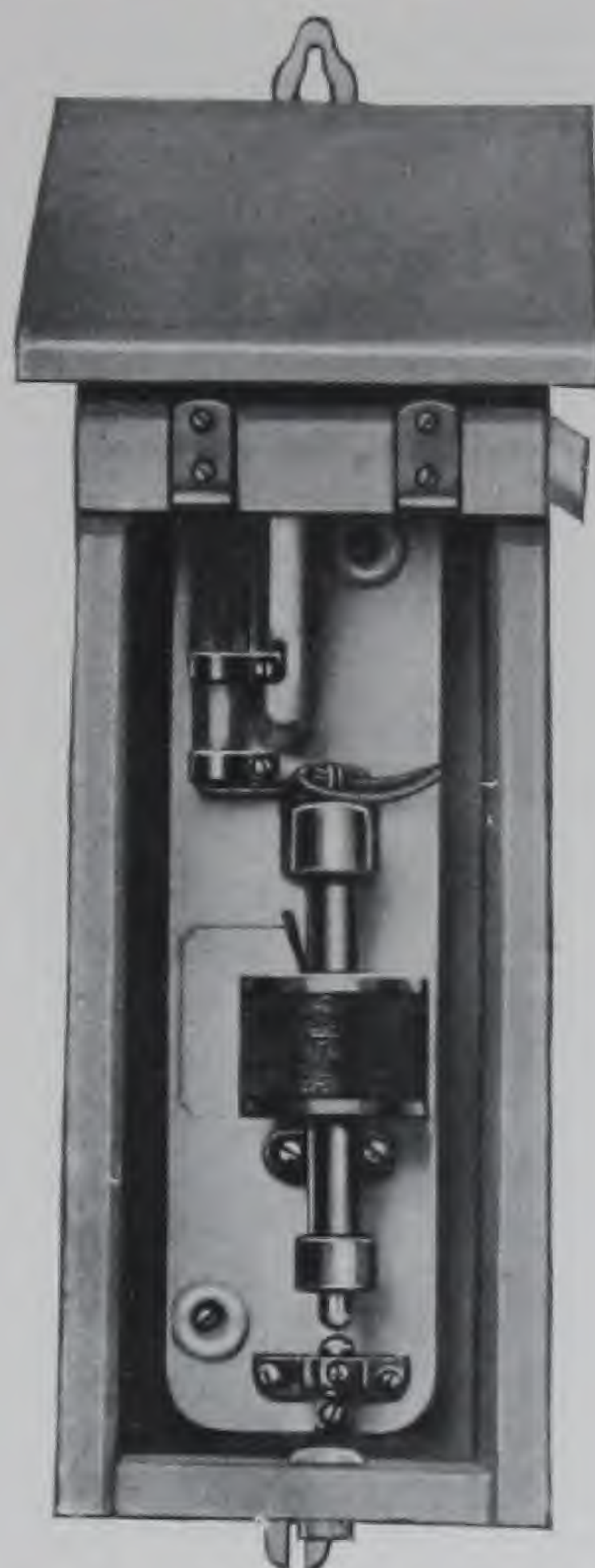
Complete listings of ground fittings, lightning arrester hangers and ground wire disconnectors are given on pages 42 to 44 inclusive.

List No.	Type	Description	Dimensions	Net Weight Each	Std. Pkg.	List Price
50404	EJ	Station	$19\frac{3}{8}$ x 4 x $3\frac{7}{8}$	$11\frac{1}{2}$ lbs.	12	\$20.00
50405	EJ	Wood Car	$21\frac{1}{2}$ x $10\frac{1}{2}$ x $6\frac{3}{4}$	21 lbs.	12	22.00
50406	EJ	Wood Covered	$25\frac{1}{4}$ x $8\frac{3}{8}$ x $7\frac{3}{4}$	$21\frac{1}{2}$ lbs.	12	22.00
50426	EK	Station	49 x 8 x $17\frac{1}{2}$	45 lbs.	6	40.00
50427	EK	Wood Covered	49 x 13 x $15\frac{1}{2}$	58 lbs.	6	44.00



## GARTON-DANIELS LIGHTNING ARRESTERS

Arc Circuit Types, Up to 6000 Volts D. C.

Station Arc Restorer,  
Type BD ArcArc Restorer in Wooden Cover, Lid  
Removed, Type BD Arc

The type BD Garton-Daniels direct current arc arresters are practically the same in construction as the arresters listed on preceding page. They, however, employ no series resistance. The flow of line current to ground through the arrester can never exceed a given value on account of the regulator, and as the circuit breaker is relied upon entirely for cutting off this flow to ground, such series resistance is unnecessary.

As seen, the discharge path through this arrester is practically all heavy metallic conductor, and on this account is very efficient.

Station and pole type arresters are of our standard finish. Pole arresters are made in wood covers only, and should be installed at intervals of every half mile.

Choke coil No. 50042, listed on page 51, is recommended for use in any arc circuit of 10 amperes or less.

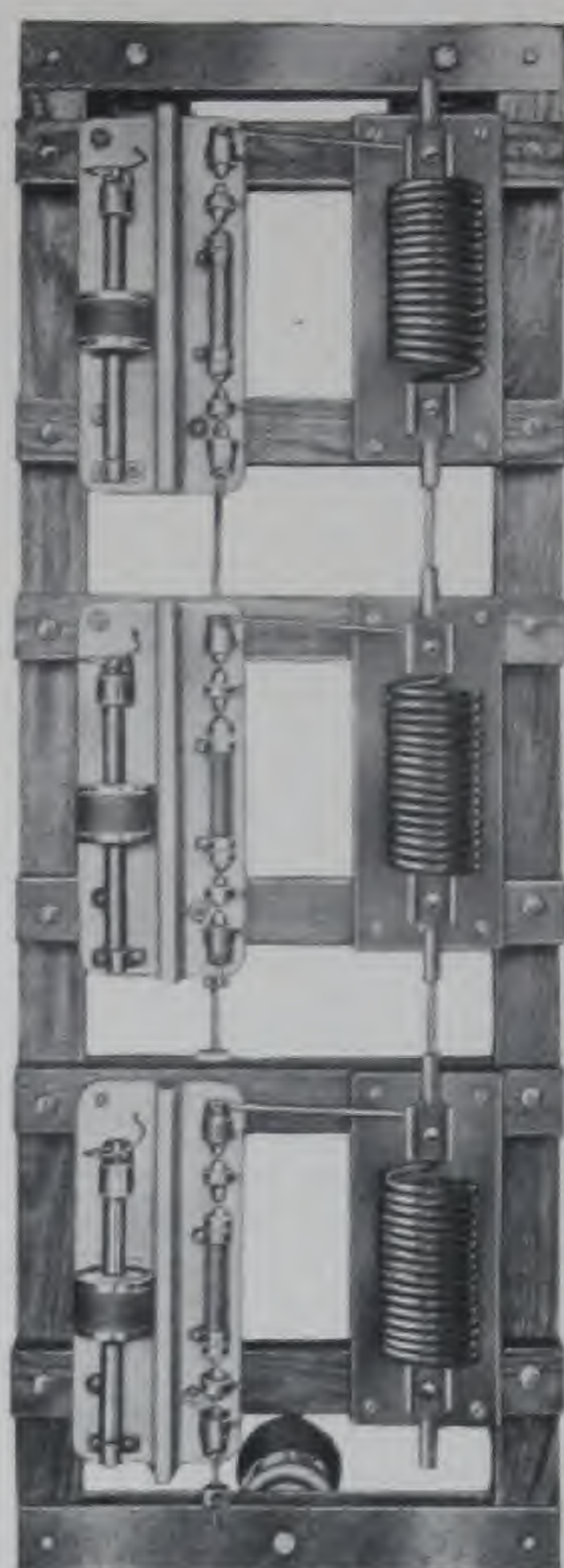
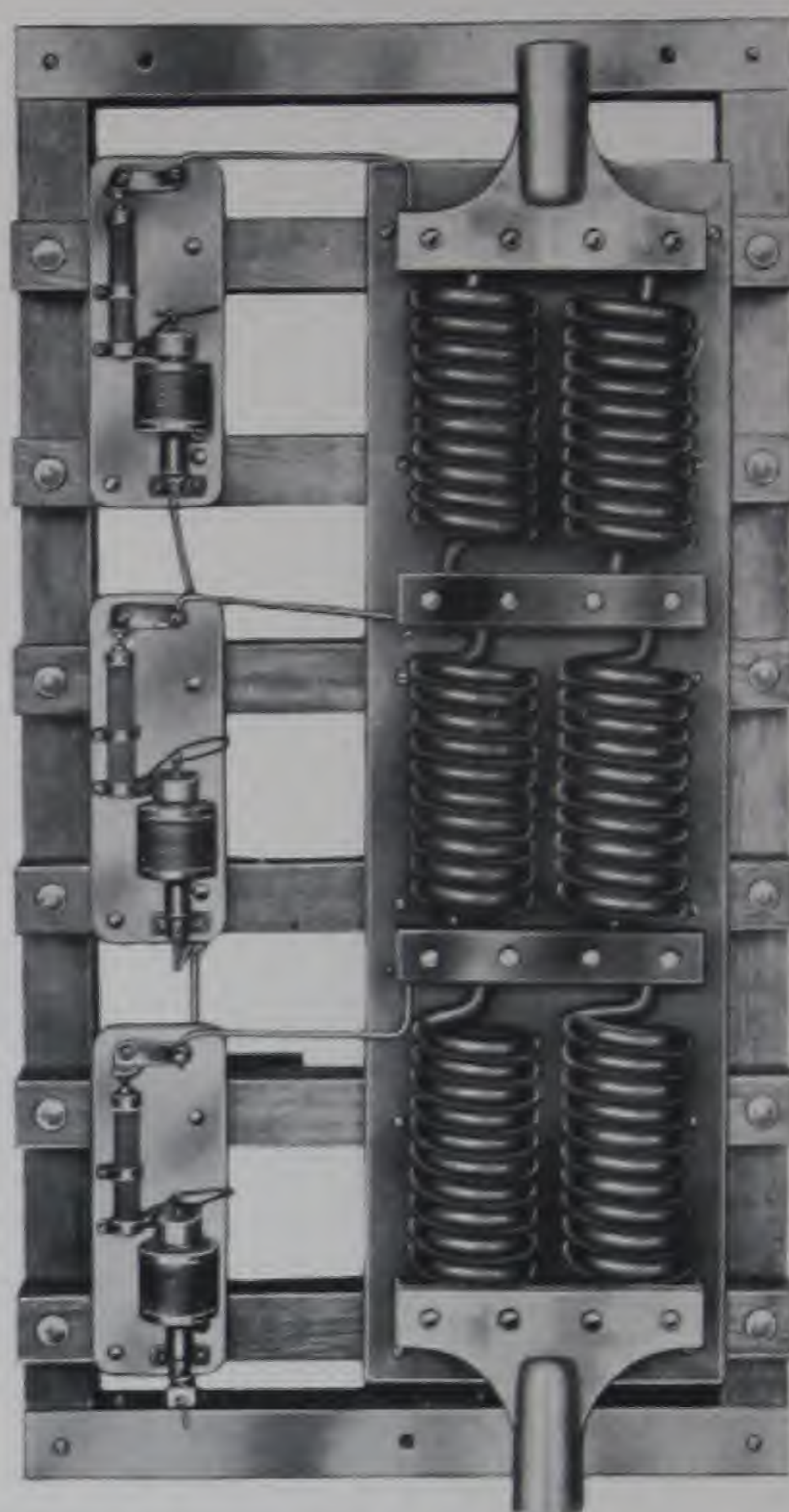
Complete listings of ground fittings, lightning arrester hangers and ground wire disconnectors are given on pages 42 to 44 inclusive.

List No.	Voltage of Circuit	Description	Net Weight Each	Standard Package	List Price
50077	Up to 4000	Station Type	6¾ lbs.	12	\$11.25
50078	Up to 4000	Wood Covered	12½ lbs.	12	12.25
50073	4000 to 6000	Station Type	20 lbs.	6	30.00
50074	4000 to 6000	Wood Covered	26½ lbs.	6	32.00



## GARTON-DANIELS LIGHTNING ARRESTERS

Panel Board Types, A. C. and D. C.

Panel Board for 2500 Volt A. C.  
ServicePanel Board for 600 Volt D. C.  
Railway Service

Garton-Daniels Panel Board lightning arresters are especially adapted for the protection of electrical machinery, either A. C. or D. C., where lightning conditions are unusually severe.

Their operation will be clearly understood from the above illustrations showing typical A. C. and D. C. Panel Board arresters.

The line or feeder runs from the upper choke coil terminal; the feeder from the generator, transformer or motor to be protected runs into the lower choke coil terminal. This places the three coils between the apparatus to be protected and the line.

The upper lightning arrester unit is connected ahead, or on the line side of the first choke coil; the middle arrester unit taps in between the first and second coils; the lower arrester unit taps in between the second and third coils. Wires run from the ground connection of each arrester to a common ground wire as shown. When installed, this is of course given a good ground connection.

In the operation of any lightning arrester, it is a well-known fact that no arrester, however efficient it may be, will carry every bit of a lightning charge to ground; some small portion will pass the arrester and find its way into the apparatus to be protected. Under unusually severe conditions, this leakage charge may be sufficient to damage or burn out the apparatus.

In these Panel Board arresters, assume that a charge has been set free on the line. The first choke coil chokes back most of this and discharges it over the first arrester unit. The leakage charge through the first choke coil must,



## GARTON-DANIELS LIGHTNING ARRESTERS

### Panel Board Types, A. C. and D. C.

as can be seen, pass two other choke coils and two other arrester units before it can get into the apparatus. The second arrester unit therefore takes a great portion of this leakage to ground. The third arrester unit similarly takes care of any leakage that has passed the first two choke coils and the first two arrester units, allowing only a very minute portion of the original charge to pass through the third choke coil and into the apparatus. Almost perfect lightning protection therefore may be expected on apparatus protected with Garton-Daniels panel board arresters.

To show the efficiency of these panel board arresters, let us assume that the first arrester unit takes off, say  $9/10$  of an incoming charge. This leaves  $1/10$  to flow past this arrester unit and through the first choke coil. If now the second arrester unit takes  $9/10$  of this leakage  $1/10$  to ground, but  $1/100$  of the original charge remains to flow through the second choke coil. Again, if the third arrester unit takes  $9/10$  of this leakage  $1/100$  to ground, but  $1/1000$  of the original charge remains to flow through the third choke coil and into the apparatus. This, as can be seen, is insignificant.

Garton-Daniels panel board arresters are designed especially for the protection of apparatus up to 6,600 volts A. C., up to 2,500 volts D. C. railway, and up to 6,000 volts D. C. Arc, and are furnished in any ampere capacity for voltages within this range.

They are made in double type, consisting of two choke coils and two arrester units, and in triple type, consisting of three choke coils and three arrester units, as shown in illustrations. One panel board, either double or triple type, is required for the protection of each wire running into or from the apparatus to be protected. They are furnished regularly in station type, without wood covers. For the few cases where they are required for outside service, operating companies usually desire to build small arrester houses for their accommodation.

Station panel boards are mounted on heavy impregnated oak frames and are furnished complete with insulators for attaching to any suitable supporting means. The arrester units are furnished with highly polished and lacquered metal work. Choke coils are of copper, black enameled and baked.

### Directions for Ordering

In ordering Garton-Daniels panel board lightning arresters, it is necessary that the following information be given:

Type desired—Double or Triple.

Class of Circuit—D. C. or A. C. If D. C., whether grounded or ungrounded, single, two or three wire. If A. C., whether single, two or three phase; two, three or four wire, grounded or ungrounded.

Voltage of circuit.

Amperes per wire in D. C. work or per phase in A. C. work.

Size of wire or cable for which terminals are to be provided, and number of terminals for heavy capacity circuits.

**LIST PRICES.** For estimating purposes only, an approximate list price may be obtained on Garton-Daniels panel board arresters by adding together the list prices of the arrester units suited for the voltage of circuit (two units for double type, three for triple type), the list price of suitable capacity, AF or AMF choke coils (see page 52), and adding to this sum \$20.00. The list price so obtained will be approximate, and is subject to our regular discounts.



## LIGHTNING ARRESTER GROUND FITTINGS

## Garton-Daniels Types



Brass Coupling

Brass Cap

External Point   Internal Point



No. 50082 Plate

Garton-Daniels pipe ground fittings, used in connection with standard  $\frac{3}{4}$ -inch or 1-inch galvanized pipe, offer a convenient, efficient and economical method of making ground connections for lightning arresters and other purposes.

The points are made of malleable iron, heavily galvanized; the external type being threaded to screw on the pipe and the internal for driving into the pipe. The couplings and caps are brass.

Ground pipe should be driven into the earth for a distance of from 6 to 10 feet or to a point where they will be continuously in damp earth.

Garton-Daniels ground plates are made of cast iron, heavily corrugated, and offer an exposed surface of 450 square inches. They are 12 inches in diameter, approximately  $\frac{3}{4}$  inch thick and weigh 9 pounds each.

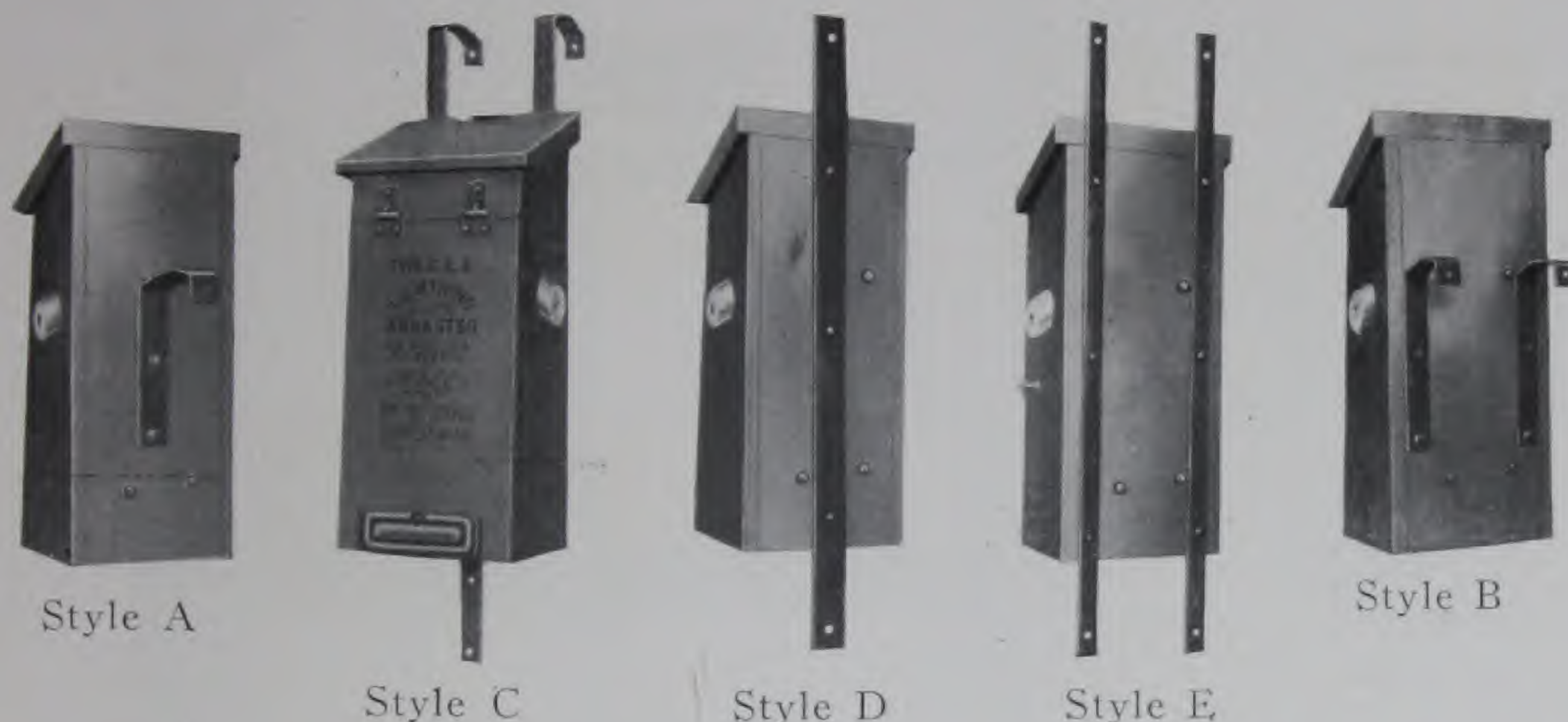
They are used in place of sheet copper ground plates and should be buried at the foot of the pole and the necessary length of pipe attached. They are drilled to receive  $\frac{3}{4}$ -inch standard iron pipe.

List No.		List Price
50079	Brass cap for $\frac{3}{4}$ -inch pipe, drilled for Nos. 4 or 6 wire	\$ .45
50428	Brass cap for $\frac{3}{4}$ -inch pipe, drilled for No. 0 wire or cable	.45
50429	Brass cap for $\frac{3}{4}$ -inch pipe, drilled for $\frac{1}{4}$ -inch cable	.45
50432	Brass cap for 1-inch pipe, drilled for No. 4 or 6 wire	.55
50433	Brass cap for 1-inch pipe, drilled for No. 0 wire or cable	.55
50434	Brass cap for 1-inch pipe, drilled for $\frac{1}{4}$ -inch cable	.55
50080	Brass coupling for $\frac{3}{4}$ -inch pipe, drilled for Nos. 4 or 6 wire	.40
50430	Brass coupling for $\frac{3}{4}$ -inch pipe, drilled for No. 0 wire or cable	.40
50435	Brass coupling for 1-inch pipe, drilled for Nos. 4 or 6 wire	.50
50436	Brass coupling for 1-inch pipe, drilled for No. 0 wire or cable	.50
50081	Malleable ground point for $\frac{3}{4}$ -inch pipe, external type	.45
50431	Malleable ground point for $\frac{3}{4}$ -inch pipe, internal type	.40
50437	Malleable ground point for 1-inch pipe, external type	.55
50438	Malleable ground point for 1-inch pipe, internal type	.50
50440	Galvanized pipe coupling for $\frac{3}{4}$ -inch pipe	.15
50441	Galvanized pipe coupling for 1-inch pipe	.20
50082	Iron ground plate tapped for $\frac{3}{4}$ -inch pipe	1.20



## LIGHTNING ARRESTER CROSS ARM HANGERS

## Garton-Daniels Types



Lightning arrester cross arm hangers as shown above are designed to support Garton-Daniels single unit lightning arresters from either one or two cross arms. Fitted with these hangers, they are easy and cheap to install, having strong, rigid supporting means and when so hung make a better appearance than the non-uniform schemes sometimes used in lightning arrester installation.

Supports A and D are made from  $1\frac{1}{2}$ " x 3-32" strap iron, and are designed especially for attaching light weight arresters, such as the types DF, FH and EG from either one, or between two cross arms.

Supports B, C and E are made from 1" x 3-32" strap iron, and are suitable for use with any single unit type of Garton-Daniels arrester. Style B support is of the single arm type; styles C and E are of the two arm type.

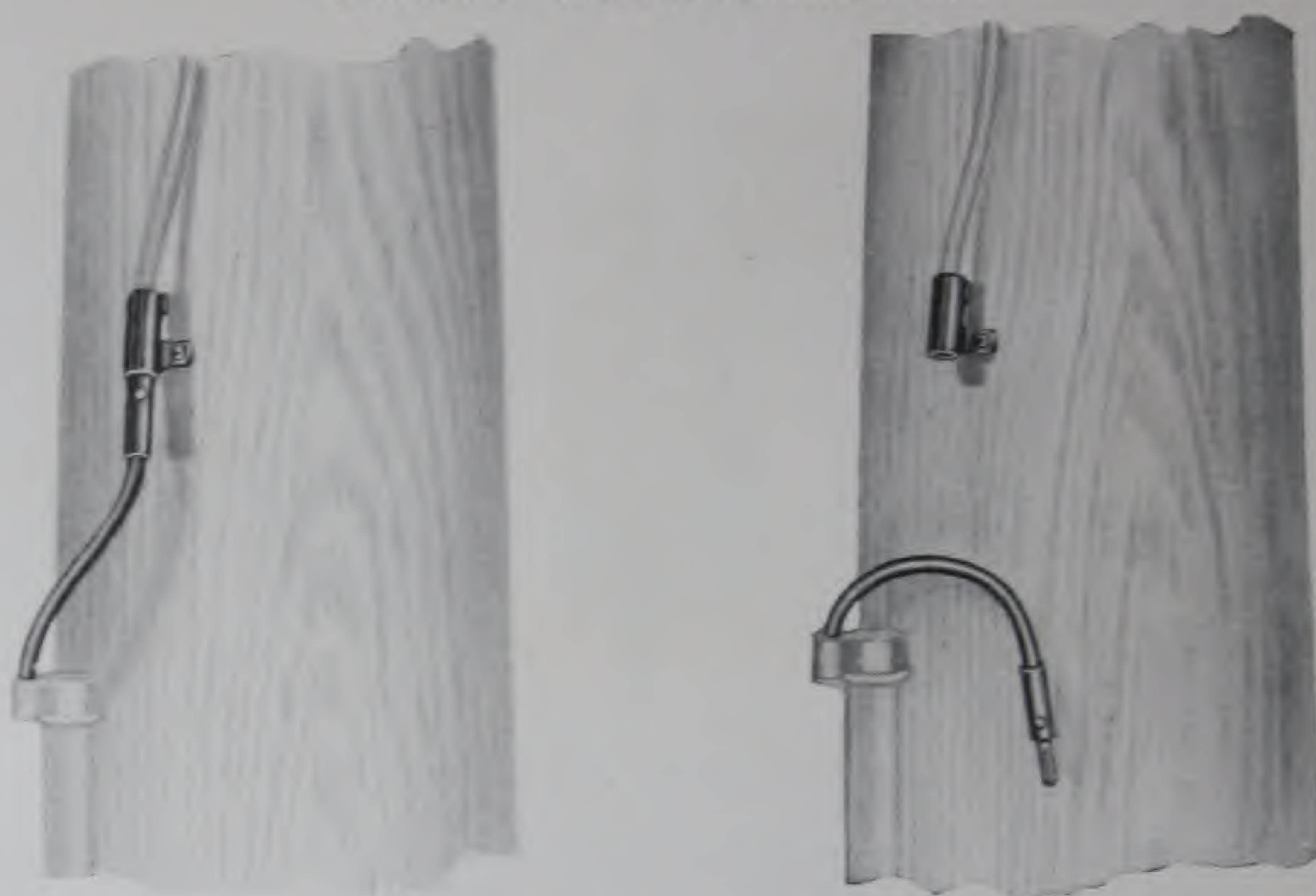
All supports are made of hot galvanized iron, attached to arrester box by suitable wood screws. Hangers, styles A, B and C, are regularly furnished for  $3\frac{1}{2}$ -inch cross arm; this regular size being entirely suitable for  $3\frac{1}{4}$ -inch arms. Styles C, D and E are regularly drilled for arms installed on 24-inch centers, this standard drilling only being carried in stock. Special drillings will be furnished to order. All hangers are furnished complete with necessary screws, and ready to be attached to box.

List No.		List Price
50421	Style A Hanger, $3\frac{1}{4}$ or $3\frac{1}{2}$ inch, single arm .....	\$ .80
50422	Style B Hanger, $3\frac{1}{4}$ or $3\frac{1}{2}$ inch, single arm .....	1.20
50423	Style C Hanger, $3\frac{1}{4}$ or $3\frac{1}{2}$ inch, double arm .....	1.40
50424	Style D Hanger, double arm .....	.80
50425	Style E Hanger, double arm .....	1.00



## GARTON-DANIELS LIGHTNING ARRESTERS

## Ground Wire Disconnectors



Garton-Daniels Ground Wire Disconnecter, showing Connected and Disconnected Positions

In the installation and grounding of lightning arresters, the ground wire presents an element of danger for a lineman who must climb the pole on a wet night, say, to replace a blown transformer fuse; because he may accidentally cross himself with the lightning arrester ground wire and with a live wire or live piece of apparatus.

Many schemes have been at times used to disconnect the lightning arrester ground wire before the lineman ascended the pole, but none have proven so reliable, so economical as the Garton-Daniels Ground Wire Disconnecter.

It consists of a brass casting designed to be screwed to the side of the pole. At the top a lug is provided into which a No. 4 or 6 B. & S. solid wire running from the lightning arrester may be soldered. At the bottom another lug is provided into which a split brass plug slides. This plug is furnished with 12 inches of No. 6 flexible copper cable, the free end of which is soldered into a standard brass cap screwed to the end of the lightning arrester ground pipe. With this method the ground pipe, as shown, is usually extended 8 or 10 feet up the pole to prevent the plug being withdrawn by any unauthorized person.

A lineman now desiring to work on the pole top for any reason whatever need simply pull out the plug as he ascends, thereby entirely disconnecting the upper wire and lightning arresters from ground, and so rendering work on the pole comparatively safe.

These Ground Wire Disconnectors are also very useful where lightning arresters are tested by connecting them between opposite phase wires. The plug being pulled disconnects the ground terminals of the arrester from earth, so making unnecessary the removal of the ground wire from the ground binding post, to prevent momentarily grounding one phase of the system while making the test.

Many other uses of these Ground Wire Disconnectors will suggest themselves to the operating man.

List No.

50444

Ground Wire Disconnecter for No. 4 or 6 B. & S. Solid

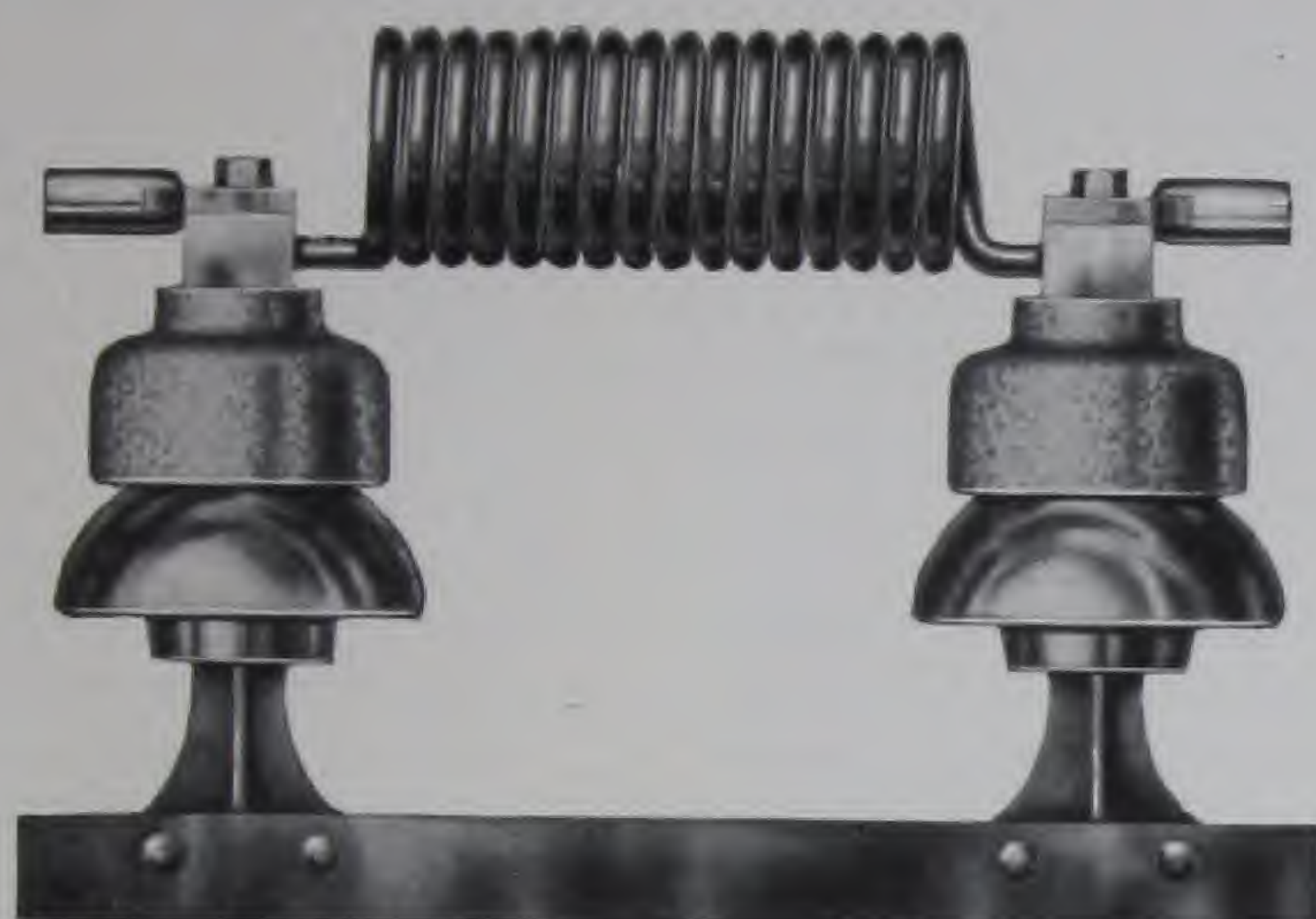
List Price

\$1.25



## GARTON-DANIELS CHOKE COILS

## High Voltage Types



Type L Choke Coil, 200 Ampere Capacity  
For 13,200 Volt Circuit



End View of  
Same Coil

When a lightning disturbance travels along a line, it usually has a very steep wave front. This incoming wave striking the highly inductive windings of a transformer or other piece of electrical apparatus dams up and frequently breaks down the insulation of the first few turns of wire, causing a burn-out and throwing the apparatus out of service.

This phenomenon is based on the well-known fact that a turn or coil of copper wire offers a high inductive resistance to the passage of high frequency alternating currents. This inductive resistance is affected very slightly by the resistance of the wire, but depends almost entirely on the inductance of the coil and on the frequency of the discharge flowing through it.

The use of choke coils is based on this phenomenon and it is to knock off the crests of these incoming waves that they are used.

If we take a coil of heavy copper wire, connect it between a generator or a transformer and the line, any high frequency currents, such as lightning usually is, will come in over the line wire, reach the choke coil, and this coil, offering a high resistance to such discharges, will cause them to choke or dam up at the terminal of the coil and be kicked back onto the line.

If now a lightning arrester be placed ahead, or on the line side of the coil, such discharges will prefer to jump the small air gaps of the arrester in preference to passing through the coil, and so will be led to ground through the arrester and will not damage electrical apparatus on the other side.

Another way to explain the advantages of choke coils is from the fact that every lightning arrester on the market has a certain dielectric spark lag; that is to say, after the lightning potential is applied to the lightning arrester, there is a brief interval—a few millionths of a second—before the lightning arrester begins to discharge, and so carry the lightning charge to ground. If there is no choke coil between the lightning arrester and the apparatus to be protected, the end turns of the apparatus receive this high voltage strain during the interval that the lightning arrester is getting into operation.

With a choke coil installed between the lightning arrester and the apparatus to be protected, the turns of the choke coil receive this high voltage strain, keeping it out of the apparatus and so protecting it.



## GARTON-DANIELS CHOKE COILS

### High Voltage Types

Choke coils are usually air insulated. It will sometimes be noticed that lightning discharges will jump several of the gaps separating the convolutions of the coil. It is immaterial whether this occur or not. Such flashing between turns can do no possible harm; the insulation, being air, is immediately re-established after the passage of the discharge.

Choke coils are generally to be recommended in the protection of all classes of electrical apparatus, *excepting cable work*. A choke coil should rarely be connected in with a cable line. This is equivalent to connecting a capacity and an inductance in series, offering the chance for excessively high voltages being built up across the terminals of both the choke coil and the cable under certain resonating conditions; consequently inviting just the troubles the choke coils were designed to eliminate.

There are two general types of choke coils—the helical type and the disc type. The former should be used wherever possible. They have lower internal static capacity than the disc type, consequently operate with greater efficiency and afford far more protection to the apparatus.

In the design of Garton-Daniels High Voltage Choke Coils much care has been given in so fixing their electrical characteristics, that when used in conjunction with suitable Garton-Daniels Lightning Arresters, maximum protection to apparatus may be expected.

The determination of the size of the coil, which influences its inductance, its weight, its price, etc., rested largely in obtaining one whose inductance was not much greater than the inductance of several end coils of, say, the average transformer used on circuits for which the coil is rated. If, for example, the inductance of the coil is equal to the inductance of the first five end turns of a transformer, the strain on these end turns produced by an incoming surge will be reduced to about one-sixth, due to the reduction of the wave front by the coil.

The lightning arrester placed ahead of the coil having a dielectric spark-lag smaller than the time constant of the choke coil, operates and relieves the strain before the charge can pass through the coil.

The problem of resonance, too, has been handled in an entirely satisfactory manner. The inductance of Garton-Daniels Choke Coils is so proportioned as to practically eliminate resonant voltages building up at transformer or generator terminals due to the presence of the coil. Surges occurring inside transformers or generators therefore do not meet with excessive inductance in passing through the coils and to the lightning arresters.

They have low internal static capacity between turns, and so always operate with great efficiency.

Their construction is clearly apparent from illustrations on preceding page and from illustrations following. Various fittings, such as pipe clamps, are listed on following pages.

Special types of choke coils, or combinations of choke coils, disconnecting switches, lightning arresters, etc., while not listed, are a part of our line. Information will be gladly furnished upon request.

### Directions for Ordering

In ordering choke coils it is necessary to give the following information in order that the coils may exactly meet your requirements.

Catalog Number;

Voltage;

Capacity in amperes;

Size of wire or cable for which terminals are to be provided;

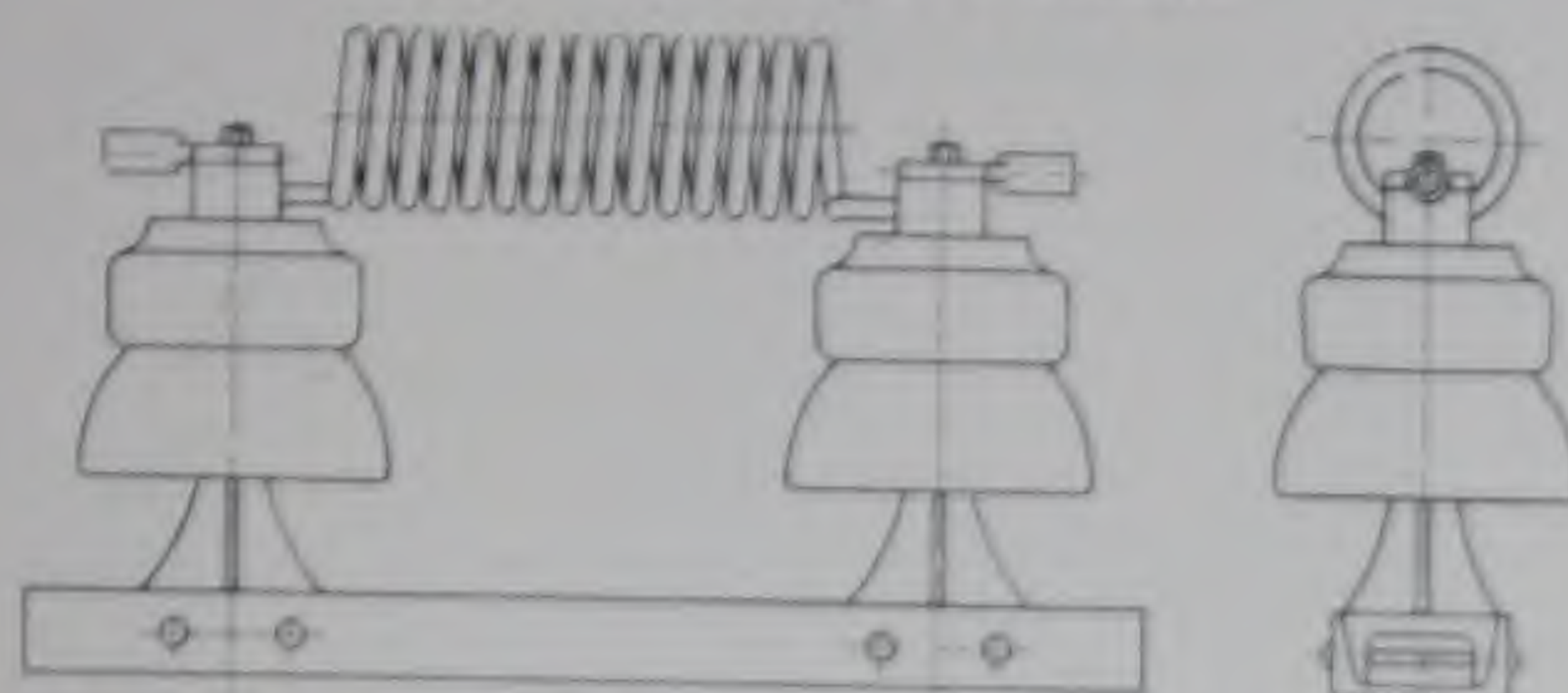
Number and size of terminals on each end when ordering Type AMF and High Voltage coils.

Mounting—standard or special, and drillings in base, if other than standard drillings are required.



## GARTON-DANIELS CHOKE COILS

## Type L, High Voltage



13,200 Volt, 200 Ampere Type L Choke Coil

Type L Choke Coils, as illustrated above, are designed for use in power and sub-stations, and in other locations where they will not be directly exposed to the elements. They are made with a base of channel iron, either 3 or 4 inch, depending on size of coil.

Channel bases are drilled with  $\frac{3}{8}$ -inch holes in each end; the coil may so be mounted on any flat supporting member by bolts or lags; or the pipe clamps described and listed in following pages may be used, furnishing suitable means of support for either parallel or transverse piping.

The details of coils necessarily vary, depending on the voltage and capacity of the circuits on which used, hence a full description of each individual coil is here impossible. Detailed blue prints of any coil will be sent on request.

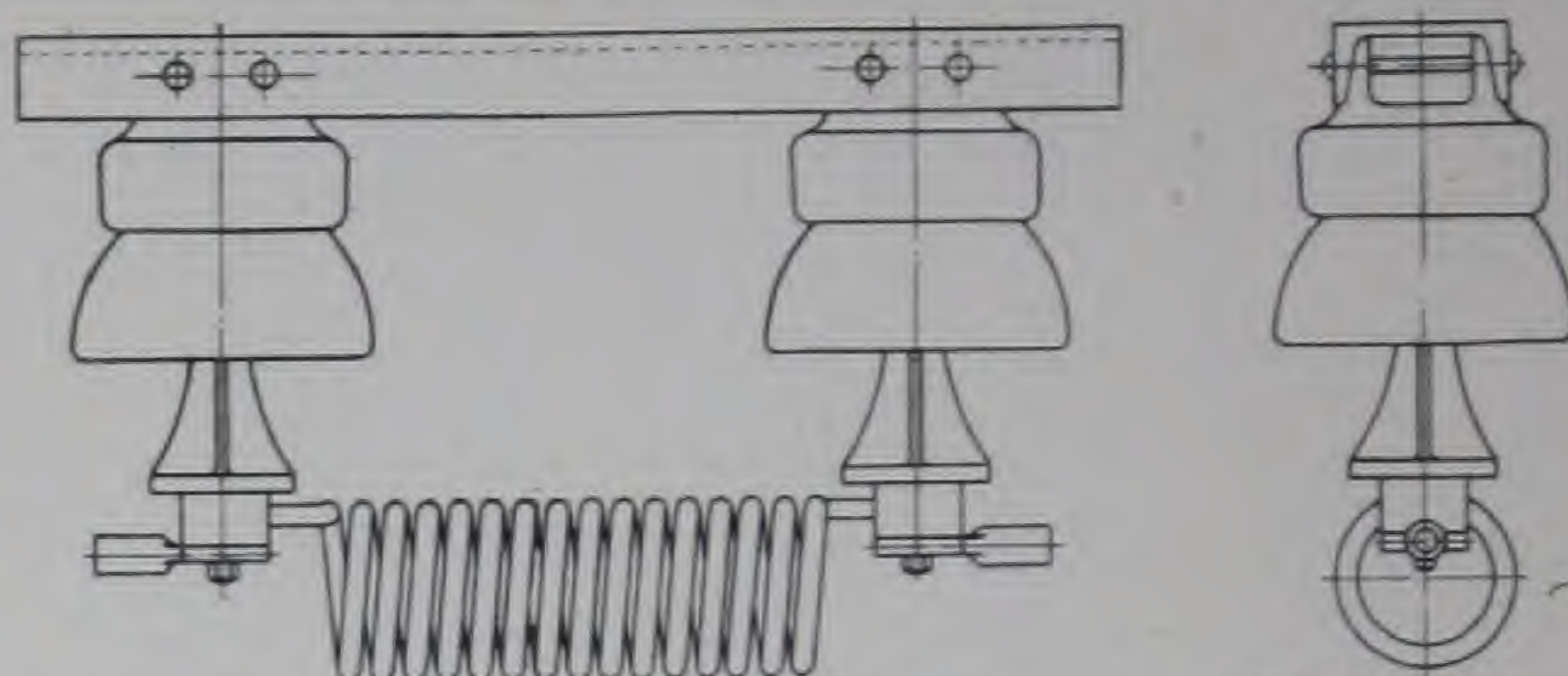
See directions for ordering choke coils on page 46.

List No.	Voltage	Capacity	List Price
50445	Up to 3,000	50 Amp.	\$17.00
50446	Up to 3,000	100 "	18.00
50447	Up to 3,000	150 "	19.00
50448	Up to 3,000	200 "	20.00
50449	Up to 3,000	250 "	21.00
50450	Up to 3,000	300 "	23.00
50451	Up to 3,000	400 "	25.00
50452	Up to 3,000	500 "	28.00
50453	Up to 3,000	600 "	31.00
50454	Up to 3,000	800 "	36.00
50455	Up to 3,000	1,000 "	46.00
50456	Up to 3,000	1,200 "	57.00
50469	3,000 to 6,600	50 "	22.00
50470	3,000 to 6,600	100 "	24.00
50471	3,000 to 6,600	150 "	25.00
50472	3,000 to 6,600	200 "	26.00
50473	3,000 to 6,600	300 "	28.00
50474	3,000 to 6,600	400 "	30.00
50475	3,000 to 6,600	500 "	33.00
50476	3,000 to 6,600	600 "	36.00
50477	3,000 to 6,600	800 "	40.00
50487	6,600 to 13,200	100 "	30.00
50488	6,600 to 13,200	200 "	33.00
50489	6,600 to 13,200	300 "	36.00
50490	6,600 to 13,200	400 "	39.00
50495	13,200 to 23,000	100 "	35.00
50496	13,200 to 23,000	200 "	38.00
50497	13,200 to 23,000	300 "	41.00
50501	23,000 to 35,000	100 "	40.00
50502	23,000 to 35,000	200 "	45.00



## GARTON-DANIELS CHOKE COILS

## Type LU, High Voltage



13,200 Volt, 200 Ampere Type LU Choke Coil

The type LU Choke Coils differ from the type L shown on preceding page in that they are of the inverted or underhung type. This type of coil is designed for use in places where it is exposed to the elements; it may so be used to protect line apparatus, being installed directly on the pole top by lagging or bolting to the under side of two cross arms. It may also be used in inside construction, and in a great many instances is preferred to the type L for this purpose, especially where it is to be hung directly overhead.

As in type L coils, the bases are drilled with  $\frac{1}{8}$ -inch holes, through which the coil may be supported by half-inch bolts; or pipe clamps may be employed, through which support is secured for either parallel or transverse piping.

Detailed blue prints of any coil listed will be furnished upon request.

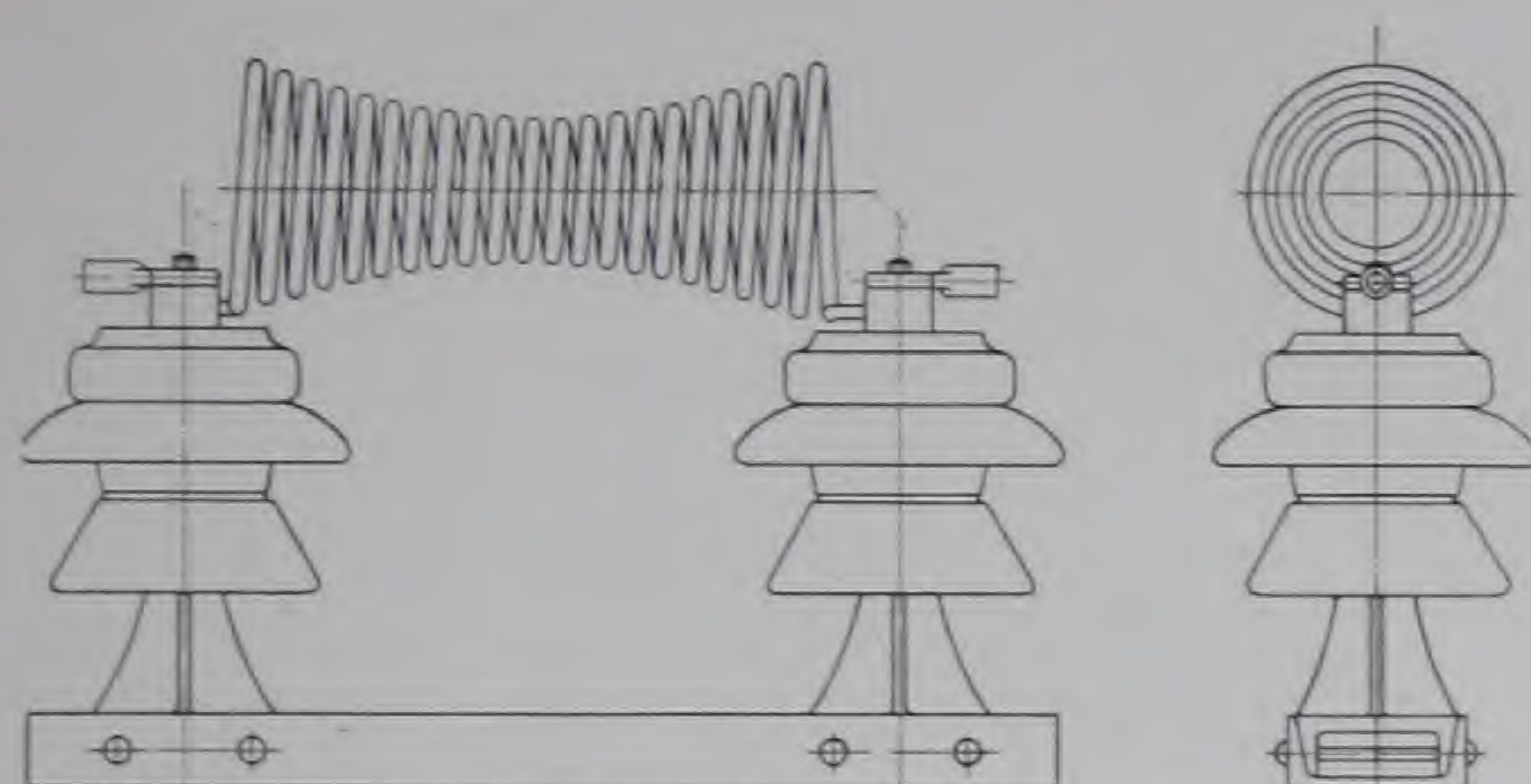
See directions for ordering choke coils on page 46.

List No.	Voltage	Capacity	List Price
50457	Up to 3,000	50 Amp.	\$17.00
50458	Up to 3,000	100 "	18.00
50459	Up to 3,000	150 "	19.00
50460	Up to 3,000	200 "	20.00
50461	Up to 3,000	250 "	21.00
50462	Up to 3,000	300 "	23.00
50463	Up to 3,000	400 "	25.00
50464	Up to 3,000	500 "	28.00
50465	Up to 3,000	600 "	31.00
50466	Up to 3,000	800 "	36.00
50467	Up to 3,000	1,000 "	46.00
50468	Up to 3,000	1,200 "	57.00
50478	3,000 to 6,600	50 "	22.00
50479	3,000 to 6,600	100 "	24.00
50480	3,000 to 6,600	150 "	25.00
50481	3,000 to 6,600	200 "	26.00
50482	3,000 to 6,600	300 "	28.00
50483	3,000 to 6,600	400 "	30.00
50484	3,000 to 6,600	500 "	33.00
50485	3,000 to 6,600	600 "	36.00
50486	3,000 to 6,600	800 "	40.00
50491	6,600 to 13,200	100 "	30.00
50492	6,600 to 13,200	200 "	33.00
50493	6,600 to 13,200	300 "	36.00
50494	6,600 to 13,200	400 "	39.00
50498	13,200 to 23,000	100 "	35.00
50499	13,200 to 23,000	200 "	38.00
50500	13,200 to 23,000	300 "	41.00
50503	23,000 to 35,000	100 "	40.00
50504	23,000 to 35,000	200 "	45.00



## GARTON-DANIELS CHOKE COILS

## Type H, High Voltage



23,000 Volt, 200 Ampere Type H Choke Coil

Type H Choke Coils, as illustrated above, are of the well-known "Hour Glass" type; they are a particularly effective form of coil where a considerable number of turns of relatively small conductor are desired, for with this form of construction the sag through the middle of the coil is practically eliminated. They so give a much better appearance than would sometimes a cylindrically wound coil.

Type H Choke Coils are constructed along lines practically identical with type L coils. Channel iron bases are used—either a standard 3-inch or 4-inch channel, depending entirely on the size of the coil. Bases are drilled with  $\frac{1}{8}$ -inch holes, through which the coil may be supported by half-inch bolts; or pipe clamps may be employed, through which suitable means of support is secured for either parallel or transverse piping.

Detailed blue prints of any coil listed will be furnished upon request.

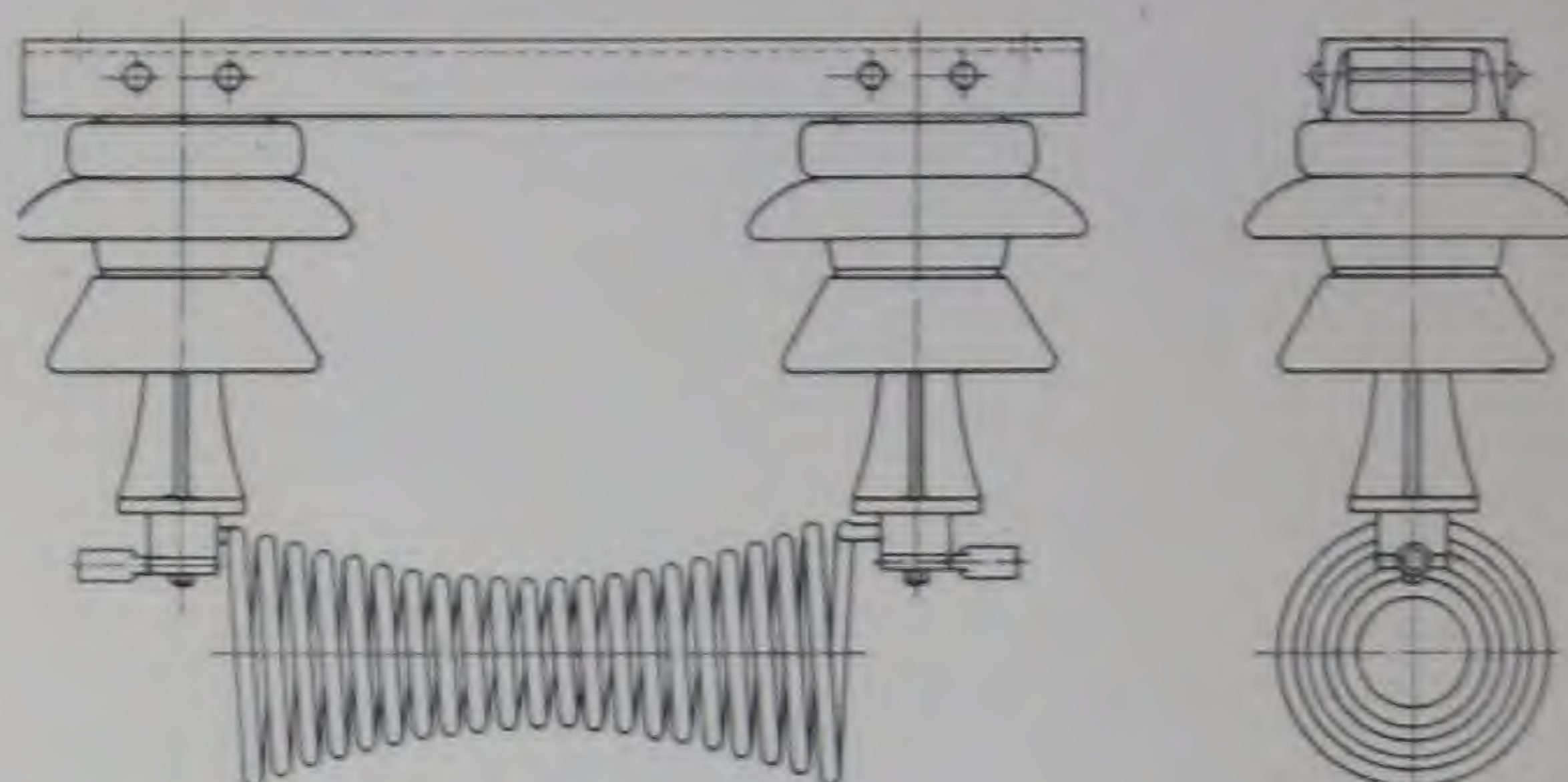
See directions for ordering choke coils on page 46.

List No.	Voltage	Capacity	List Price
50505	Up to 6,600	50 Amp.	\$24.00
50506	Up to 6,600	100 "	26.00
50507	Up to 6,600	150 "	27.00
50508	Up to 6,600	200 "	28.00
50509	Up to 6,600	300 "	30.00
50510	Up to 6,600	400 "	33.00
50511	Up to 6,600	500 "	36.00
50519	6,600 to 13,200	50 "	32.00
50520	6,600 to 13,200	100 "	35.00
50521	6,600 to 13,200	200 "	38.00
50522	6,600 to 13,200	300 "	39.00
50523	6,600 to 13,200	400 "	42.00
50529	13,200 to 23,000	100 "	37.00
50530	13,200 to 23,000	200 "	41.00
50531	13,200 to 23,000	300 "	44.00
50535	23,000 to 35,000	100 "	43.00
50536	23,000 to 35,000	200 "	48.00



## GARTON-DANIELS CHOKE COILS

## Type HU, High Voltage



23,000 Volt 200 Ampere Type HU Choke Coil

The type HU Choke Coils differ from the type H shown above in that they are of the inverted or underhung type. This type of coil is designed for use in places where it is exposed to the elements; it may so be used to protect line apparatus, being installed directly on the pole top by lagging or bolting to the under side of two cross arms. It may also be used in inside construction, and in a great many instances is preferred to the type H for this purpose, especially where it is to be hung directly overhead.

As in type H coils, the bases are drilled with  $\frac{1}{8}$ -inch holes, through which the coil may be supported by half-inch bolts; or pipe clamps may be employed, through which suitable means of support is secured for either parallel or transverse piping.

Detailed blue prints of any coil listed will be furnished upon request.

See directions for ordering choke coils on page 46.

List No.	Voltage	Capacity	List Price
50512	Up to 6,600	50 Amp.	\$24.00
50513	Up to 6,600	100 "	26.00
50514	Up to 6,600	150 "	27.00
50515	Up to 6,600	200 "	28.00
50516	Up to 6,600	300 "	30.00
50517	Up to 6,600	400 "	33.00
50518	Up to 6,600	500 "	36.00
50524	6,600 to 13,200	50 "	32.00
50525	6,600 to 13,200	100 "	35.00
50526	6,600 to 13,200	200 "	38.00
50527	6,600 to 13,200	300 "	39.00
50528	6,600 to 13,200	400 "	42.00
50532	13,200 to 23,000	100 "	37.00
50533	13,200 to 23,000	200 "	41.00
50534	13,200 to 23,000	300 "	44.00
50537	23,000 to 35,000	100 "	43.00
50538	23,000 to 35,000	200 "	48.00



## GARTON-DANIELS CHOKE COILS

Types S and Car, Low Voltage



Type S Choke Coil



Car Choke Coil

The type S low voltage choke coils are made from spiral or flat copper wire, properly insulated and held between two polished black slate discs. Terminals, which are removable on coils of 50 amperes capacity and above, are mounted on the front discs.

These choke coils are made up to 260 amperes capacity, and are suitable for use on circuits up to 2500 volts, either A. C. or D. C. For higher capacity coils, the types AF and AMF are recommended.

Car type choke coils are made from a coil of heavily insulated copper wire, mounted on a wood mandrel, and are furnished on plain-dipped slate bases. All coils are fitted with standard cylindrical wire connectors for connecting into the car circuit.

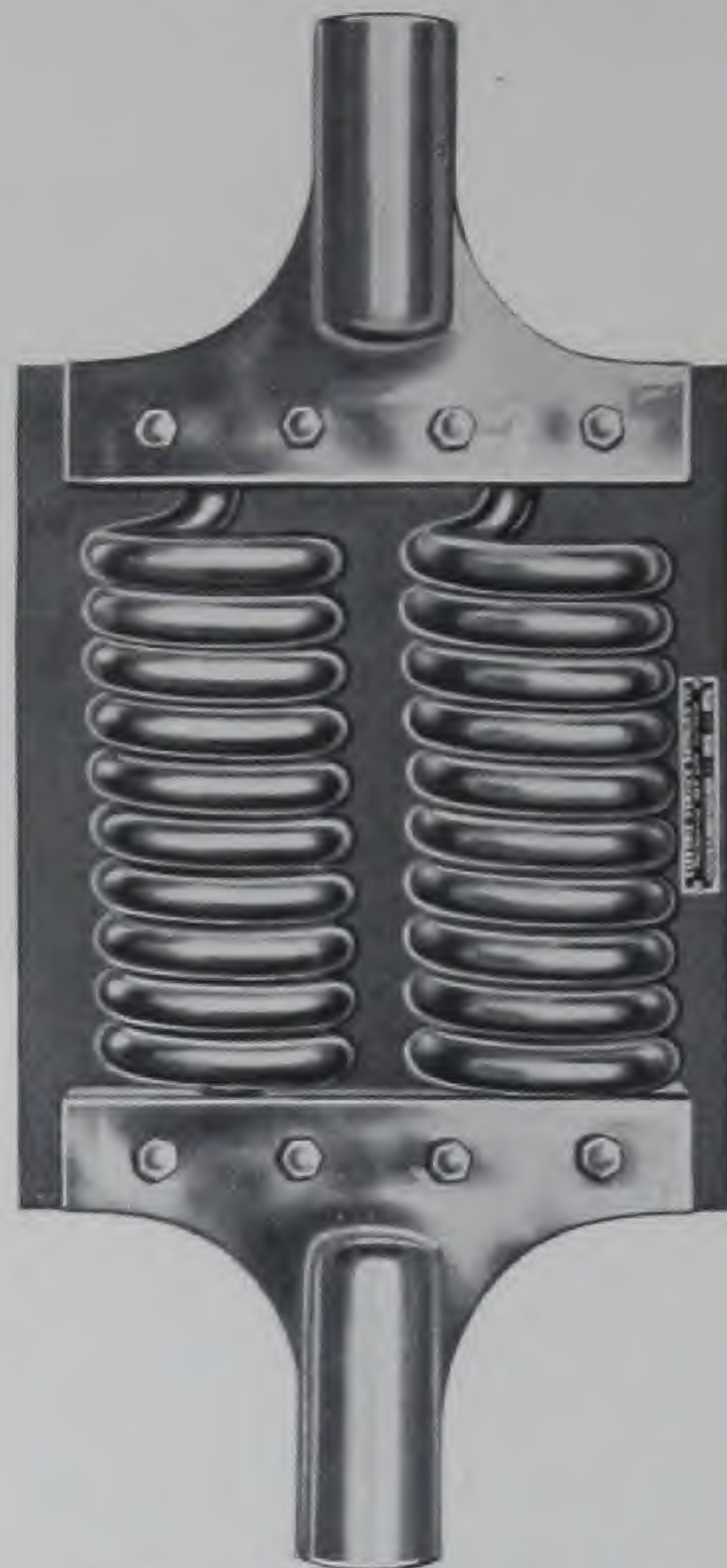
See directions for ordering choke coils on page 46.

List No.	Type	Capacity	Dimensions in Inches	Net Weight Each	List Price
50042	S	10 Amp.	Diam. $6\frac{5}{8}$ x $2\frac{1}{2}$	4 lbs.	\$3.60
50043	S	20 "	" $6\frac{5}{8}$ x $2\frac{1}{2}$	4 lbs.	4.80
50044	S	30 "	" $6\frac{5}{8}$ x $2\frac{1}{2}$	4 lbs.	5.76
50045	S	40 "	" $6\frac{5}{8}$ x $2\frac{1}{2}$	4 lbs.	6.72
50046	S	50 "	" $8\frac{1}{8}$ x $3\frac{7}{16}$	$9\frac{1}{4}$ lbs.	8.00
50047	S	100 "	" $8\frac{1}{8}$ x $3\frac{7}{16}$	$9\frac{1}{4}$ lbs.	8.50
50048	S	125 "	" $8\frac{1}{8}$ x $3\frac{7}{16}$	$9\frac{1}{4}$ lbs.	9.00
50049	S	175 "	" $9\frac{5}{8}$ x $3\frac{9}{16}$	$16\frac{1}{4}$ lbs.	10.00
50050	S	225 "	" $9\frac{5}{8}$ x $3\frac{9}{16}$	$16\frac{1}{4}$ lbs.	10.50
50051	S	260 "	" $9\frac{5}{8}$ x $3\frac{9}{16}$	$16\frac{1}{4}$ lbs.	11.00
11781	Car	75 "	$10\frac{1}{2}$ x $4\frac{3}{8}$ x $4\frac{3}{4}$	$8\frac{3}{4}$ lbs.	7.00
11782	"	125 "	$10\frac{1}{2}$ x $4\frac{3}{8}$ x $4\frac{3}{4}$	10 lbs.	7.75
11783	"	150 "	$10\frac{1}{2}$ x $4\frac{3}{8}$ x 5	$10\frac{3}{4}$ lbs.	8.50
11784	"	175 "	$10\frac{1}{2}$ x $4\frac{3}{8}$ x 5	$11\frac{1}{2}$ lbs.	9.25
11785	"	200 "	$10\frac{1}{2}$ x $4\frac{3}{8}$ x 5	$12\frac{1}{4}$ lbs.	10.00



## GARTON-DANIELS CHOKE COILS

Types AF and AMF, Low Voltage



Type AMF Choke Coil



Type AF Choke Coil

Types AF and AMF Choke Coils are made in capacities ranging from 50 to 2,000 amperes. All coils are furnished with separable terminals; type AF coils up to 500 amperes are of the single terminal type as illustrated; type AMF coils for 600 amperes and above are of the multiple terminal types.

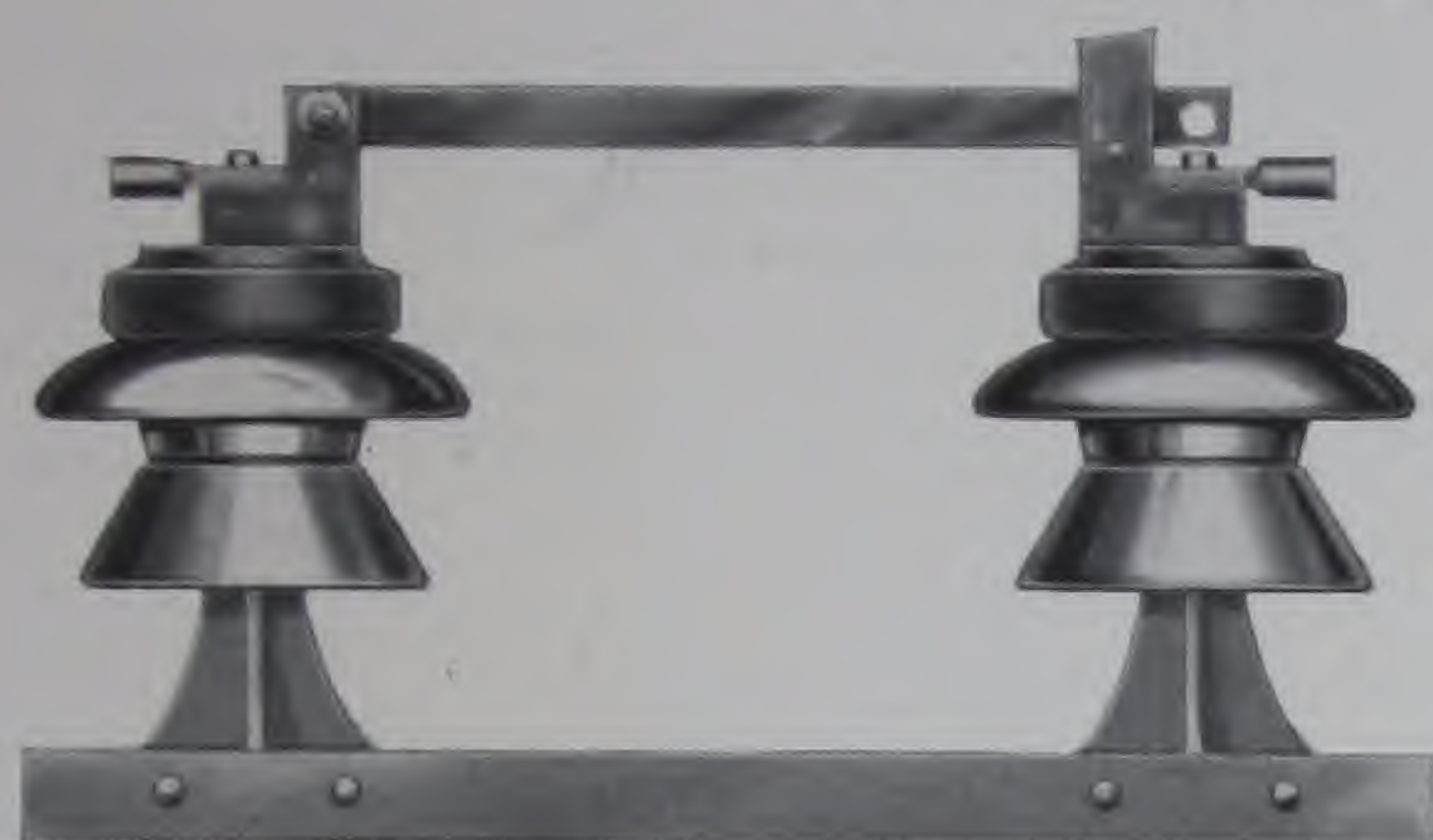
These coils are regularly furnished on plain dipped slate bases. Marble or marbleized slate bases will be furnished to order. Prices on these special mountings, as well as prices on coils above 2,000 amperes capacity, will be furnished on request. See directions for ordering choke coils on page 46.

List No.	Type	Capacity	Dimensions in Inches			Net Weight Each	List Price
50052	AF	50 Amp.	10½	x	4¾ x 5	8½ lbs.	\$9.90
50053	"	125 "	10½	x	4¾ x 5	8½ lbs.	11.00
50054	"	160 "	12	x	5 x 5	11 lbs.	11.50
50055	"	200 "	12	x	5 x 5	11½ lbs.	11.90
50056	"	250 "	12	x	5 x 5	12¼ lbs.	12.10
50057	"	325 "	5	x	15½ x 4½	15½ lbs.	13.20
50058	"	400 "	5	x	16 x 4½	18¾ lbs.	18.70
50059	"	500 "	5	x	16¾ x 4½	21¼ lbs.	27.50
50060	AMF	600 "	10	x	17 x 4½	33¾ lbs.	29.70
50061	"	800 "	10	x	18½ x 4½	37¾ lbs.	35.20
50062	"	1,000 "	10	x	20⅞ x 4½	48¾ lbs.	49.50
50063	"	1,200 "	12	x	22 x 4½	65½ lbs.	55.00
50064	"	1,500 "	12	x	22 x 4½	72 lbs.	67.10
50065	"	1,600 "	14	x	23 x 4½	89¾ lbs.	74.80
50066	"	2,000 "	14	x	23 x 4½	102 lbs.	105.60



## G-D DISCONNECTING SWITCHES

## High Voltage Types

Type R Disconnecting Switch, 200 Ampere Capacity,  
for 23,000 Volt CircuitEnd View of  
Same Switch

The general purpose of a disconnecting switch is to isolate apparatus from a live circuit for purpose of inspection, test, repair or replacement.

Most of the essential points regarding their uses are given below.

*Lightning Arresters:*—It is vitally necessary that disconnecting switches be used with lightning arrester installations, especially installations above 2500 volts. They are installed between the line and the arrester, and, when opened, entirely disconnect the arrester from the line. It then may be cleaned, inspected or adjusted with entire safety.

It might be mentioned that a lightning arrester disconnecting switch carries no current except while the arrester is discharging. Hence mechanical and insulation strength, and not current carrying capacity, are the governing factors in the design of such switches. A switch nominally rated at 100 or 200 amperes is the size generally used for this service.

*Sectionalizing Bus Bars:*—It is frequently necessary and desirable to provide means for sectionalizing high tension bus bars. Disconnecting switches located in the bus bar compartments effectively meet this need.

*Sectionalizing Feeders:*—Here again disconnecting switches offer a cheap and reliable means for the sectionalizing of feeder circuits.

*Oil Switch Protection:*—A practice that is being used considerably at the present time is that of locating disconnecting switches in series with the bus bar side of high tension oil circuit breakers or switches.

When necessary to inspect or adjust breaker or switch mechanisms, the disconnecting switch is opened, and such inspection or adjustment may be carried on without danger. Another advantage in this use of disconnecting switches is that in case the circuit breaker or switch should become defective and fail in service, or should it develop short circuits within itself, the disconnecting switch may be opened and the trouble so be localized to the one defective piece of apparatus.

*High Tension Overhead Circuits:*—Disconnecting switches find a wide field of application in controlling overhead electrical circuits. They may be used for isolating sections of line on which trouble has occurred, so preventing the trouble from spreading from one defective section to other portions of the system; they may be used for controlling branch feeder sections; for throwing in emergency lines, for controlling high voltage transformer installations and for many more instances which will be apparent to the operating man.

Many uses for disconnecting switches other than those mentioned above will be found; they should be freely used and recommended.



## G-D DISCONNECTING SWITCHES

### High Voltage Types

Garton-Daniel Disconnecting Switches are made in several types and for the various voltages as listed on following pages are constructed with a base of standard channel iron (excepting type RM), either 3 inch or 4 inch, depending on the size of the switch. Iron pins are riveted to this base and insulators cemented to these pins support iron caps, which in turn support the terminal blocks, terminals and switch proper.

The use of the channel iron base permits these switches to be installed directly on a pole, to be mounted across two cross arms provided for switch supports, to be mounted on switchboards direct or to any other suitable supporting means. Each channel is provided with two  $\frac{9}{16}$ -inch holes, half-inch bolts or lags being used for direct support. Pipe clamps may be employed, through which suitable means of support is secured for either parallel or transverse piping.

The blades and wipes of these switches are made of machine-finished, pure, hard-drawn, copper; wipes being sweated into slots milled into the heavy brass terminal blocks. Tension screws are provided for the wipes at each end, and blades are ground to an accurate fit before being shipped. Wipes on all switches are flared out, as shown, to facilitate the closing of the switch; this is an especially desirable feature, especially on high voltage switches having long blades. All brass and copper parts are highly polished and lacquered. Separable terminals are provided on these switches for all capacities.

Disconnecting switches are not designed for opening under load, excepting in emergency. Switch blades have  $\frac{5}{8}$  inch diameter holes in which may be engaged the switch hooks, as listed on page 59. In cases where larger switch blade holes are desired the use of a switch blade operating attachment as listed on page 61 is recommended.

Disconnecting switches are not furnished as standard (except inverted types) with switch locks which are listed on page 59, although they are strongly recommended to prevent switch blade from blowing open. Much trouble has at times been felt with disconnecting switches blowing open under certain conditions. When a switch blade carries a heavy current such as would blow through it due to an abnormal current surge, a heavy magnetic field is generated around the blade. This magnetic field acting against the field set up by other cables, conductors, or against iron work in close proximity to the switch, causes the blade to be blown open.

The construction of Garton-Daniels disconnecting switches is such as to provide ruggedness, strength and great durability. In their design a wide factor of safety is used, thus rendering break-downs, punctures, etc., most improbable.

For use as a lightning arrester disconnecting switch, the 100 or 200 ampere size should be specified. For other work, the size specified should be governed by the ampere capacity of the circuit on which they are to be used.

### Directions for Ordering

In ordering disconnecting switches, always give the following information:  
Catalog number or code word;  
Voltage.  
Capacity in amperes.

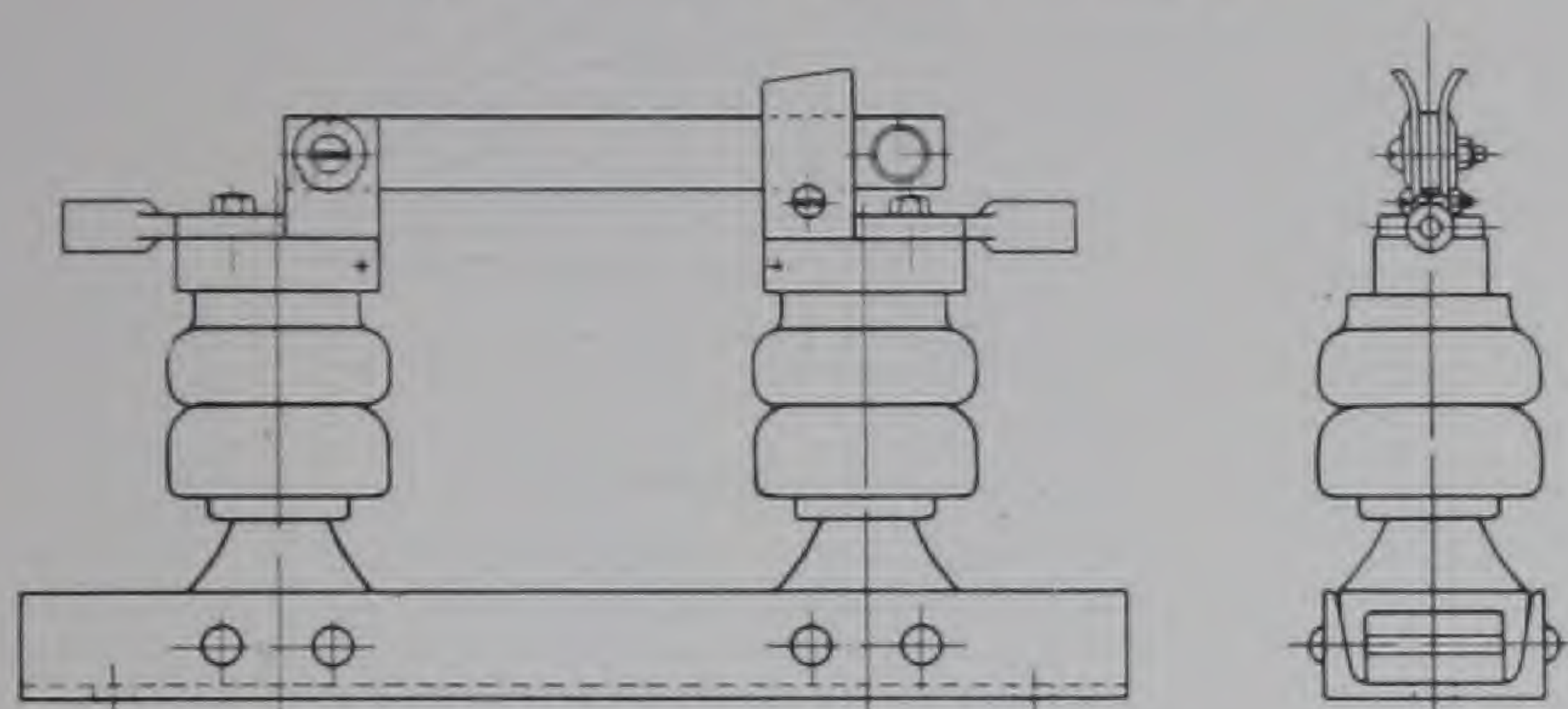
Number of terminals and size of wire or cable for which terminals are to be provided.

Mountings, standard or special, and drillings in base, if other than standard drillings are required.



## G-D DISCONNECTING SWITCHES

## Type R, High Voltage



3000 Volt, 200 Ampere Type R Switch

The Type R Disconnecting Switch for the various voltages listed below is constructed with a base of standard channel iron, either 3 inch or 4 inch, depending on the size of the switch. Iron pins are riveted to this base and insulators cemented to these pins support iron caps, which in turn support the terminal blocks, terminals and switch proper.

The use of the channel iron base permits the switch to be installed directly on a pole, to be mounted across two cross arms provided for switch supports, to be mounted on switchboards direct or to any other suitable supporting means. Each channel is provided with two  $\frac{1}{8}$ -inch holes, half-inch bolts or lags being used for direct support. Or pipe clamps may be employed, through which suitable means of support is secured for either parallel or transverse piping. Detailed blue prints of any switch will be furnished on request.

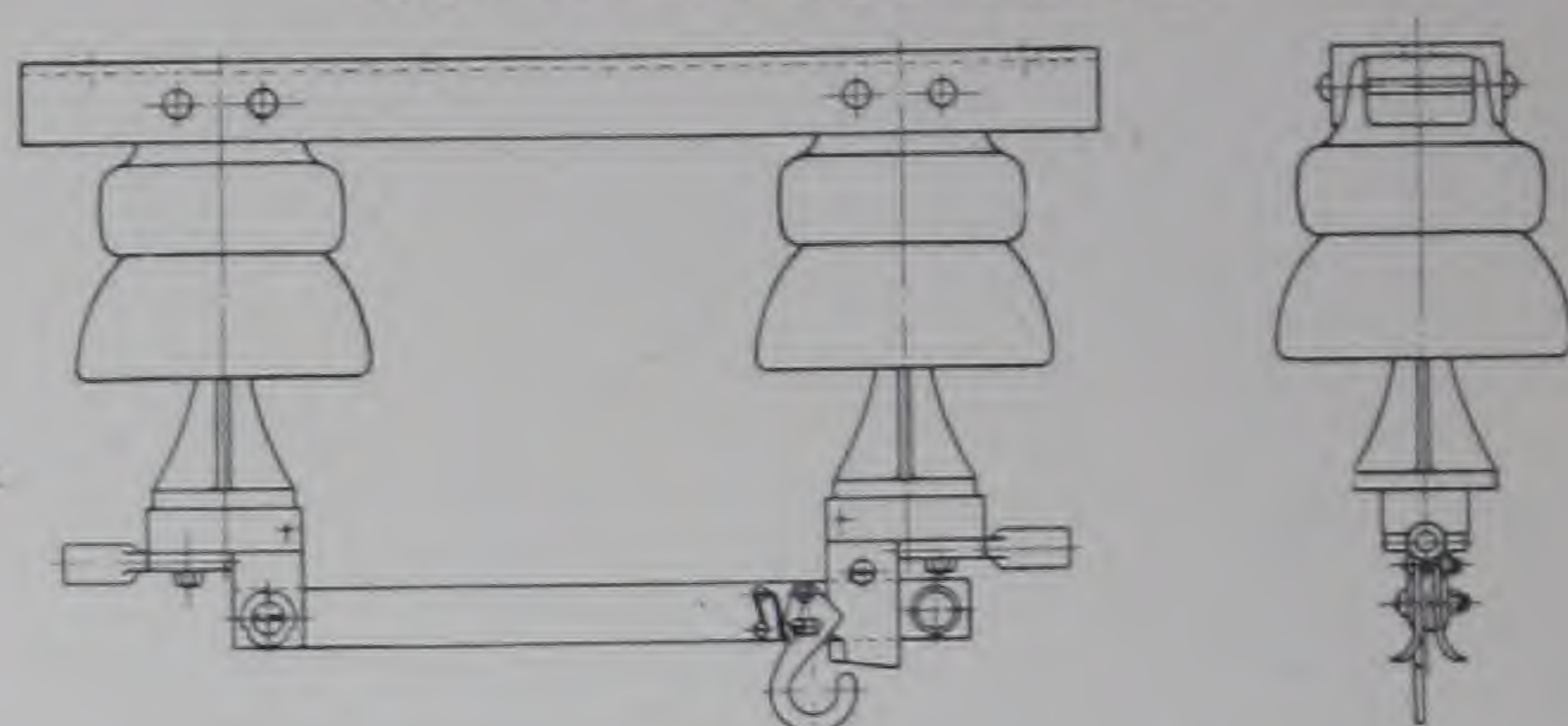
See directions for ordering switches on page 54.

List No.	Voltage	Capacity	List Price
50539	Up to 3,000	100 Amp.	\$11.50
50540	Up to 3,000	200 "	12.00
50541	Up to 3,000	300 "	14.00
50542	Up to 3,000	400 "	16.50
50543	Up to 3,000	500 "	20.00
50544	Up to 3,000	600 "	24.00
50545	Up to 3,000	800 "	30.00
50546	Up to 3,000	1,000 "	36.00
50547	Up to 3,000	1,200 "	43.00
50566	3,000 to 6,600	100 "	12.50
50567	3,000 to 6,600	200 "	13.00
50568	3,000 to 6,600	300 "	15.00
50569	3,000 to 6,600	400 "	17.50
50570	3,000 to 6,600	500 "	21.00
50571	3,000 to 6,600	600 "	25.00
50572	3,000 to 6,600	800 "	31.00
50580	6,600 to 13,200	100 "	14.00
50581	6,600 to 13,200	200 "	15.00
50582	6,600 to 13,200	300 "	17.00
50583	6,600 to 13,200	400 "	20.00
50584	6,600 to 13,200	500 "	24.00
50585	6,600 to 13,200	600 "	29.00
50592	13,200 to 23,000	100 "	21.50
50593	13,200 to 23,000	200 "	22.50
50594	13,200 to 23,000	300 "	24.00
50598	23,000 to 35,000	200 "	32.00



## G-D DISCONNECTING SWITCHES

## Type RU, High Voltage



13,200 Volt, 200 Ampere Type RU Switch

The Type RU Disconnecting Switch differs from the type R in that it is of the inverted or underhung type. This type of switch is designed for use in places where it is exposed to the elements; it may so be used in line installations, being installed directly on the pole top by lagging or bolting to the under side of two cross arms. It may also be used in inside construction, and in a great many instances is preferred to the type R for this purpose, especially where it is to be hung directly overhead.

All type RU disconnecting switches are provided with switch locks, to prevent the switch either dropping open accidentally or being blown open, due to abnormal current flows through the blade. Any of the special switch fittings, such as pipe clamps or stops, may be used with the type RU switch as with the other types. Detailed blue prints of any switch will be furnished upon request.

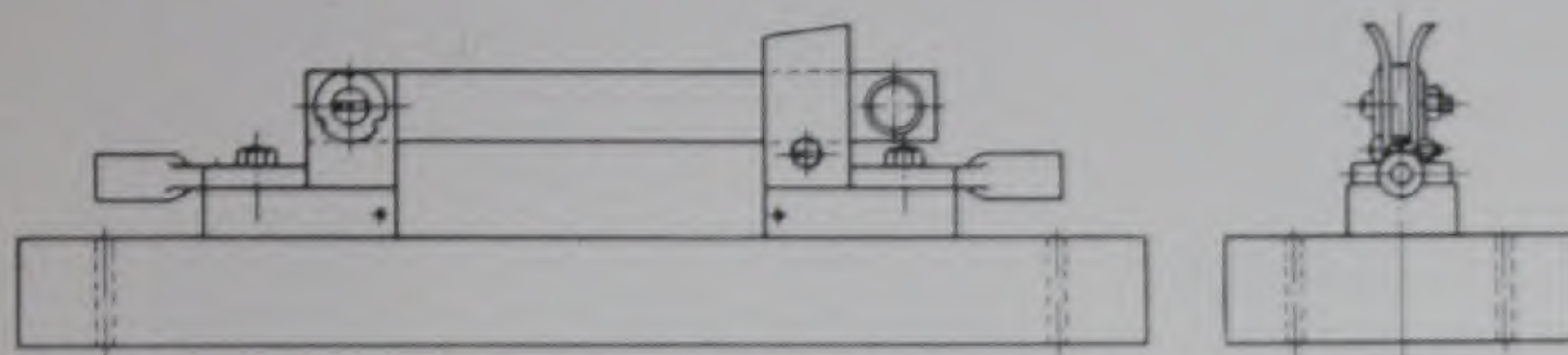
See directions for ordering switches on page 54.

List No.	Voltage	Capacity	List Price
50548	Up to 3,000	100 Amp.	\$15.50
50549	Up to 3,000	200 "	16.00
50550	Up to 3,000	300 "	18.00
50551	Up to 3,000	400 "	20.50
50552	Up to 3,000	500 "	24.00
50553	Up to 3,000	600 "	28.00
50554	Up to 3,000	800 "	34.00
50555	Up to 3,000	1,000 "	40.00
50556	Up to 3,000	1,200 "	47.00
50573	3,000 to 6,600	100 "	16.50
50574	3,000 to 6,600	200 "	17.00
50575	3,000 to 6,600	300 "	18.00
50576	3,000 to 6,600	400 "	21.50
50577	3,000 to 6,600	500 "	25.00
50578	3,000 to 6,600	600 "	29.00
50579	3,000 to 6,600	800 "	35.00
50586	6,600 to 13,200	100 "	18.00
50587	6,600 to 13,200	200 "	19.00
50588	6,600 to 13,200	300 "	21.00
50589	6,600 to 13,000	400 "	24.00
50590	6,600 to 13,200	500 "	28.00
50591	6,600 to 13,200	600 "	33.00
50595	13,200 to 23,000	100 "	25.50
50596	13,200 to 23,000	200 "	26.50
50597	13,200 to 23,000	300 "	28.00
50599	23,000 to 35,000	200 "	36.00



## G-D DISCONNECTING SWITCHES

## Type RM, High Voltage



Type RM Switch, 200 Ampere Capacity

The type RM disconnecting switch is essentially the switch structure of the type R mounted on a blue Vermont marble base instead of the channel base, pins, insulators and caps as is standard with the type R. The type RM switch may safely be used on circuits operating at voltages up to 2500, it being installed inside power or sub-station, or in some other location where it is not exposed to the elements.

Bases are regularly drilled with four corner holes, though other drillings will be furnished to order. The pipe clamps listed in the following pages may be used with these switches, so providing means for supporting from either parallel or transverse piping. Any of the other special fittings, such as locks, stops or blade operating attachments, may be used with type RM switches.

Detailed blue prints of any of the switches listed will be furnished upon request.

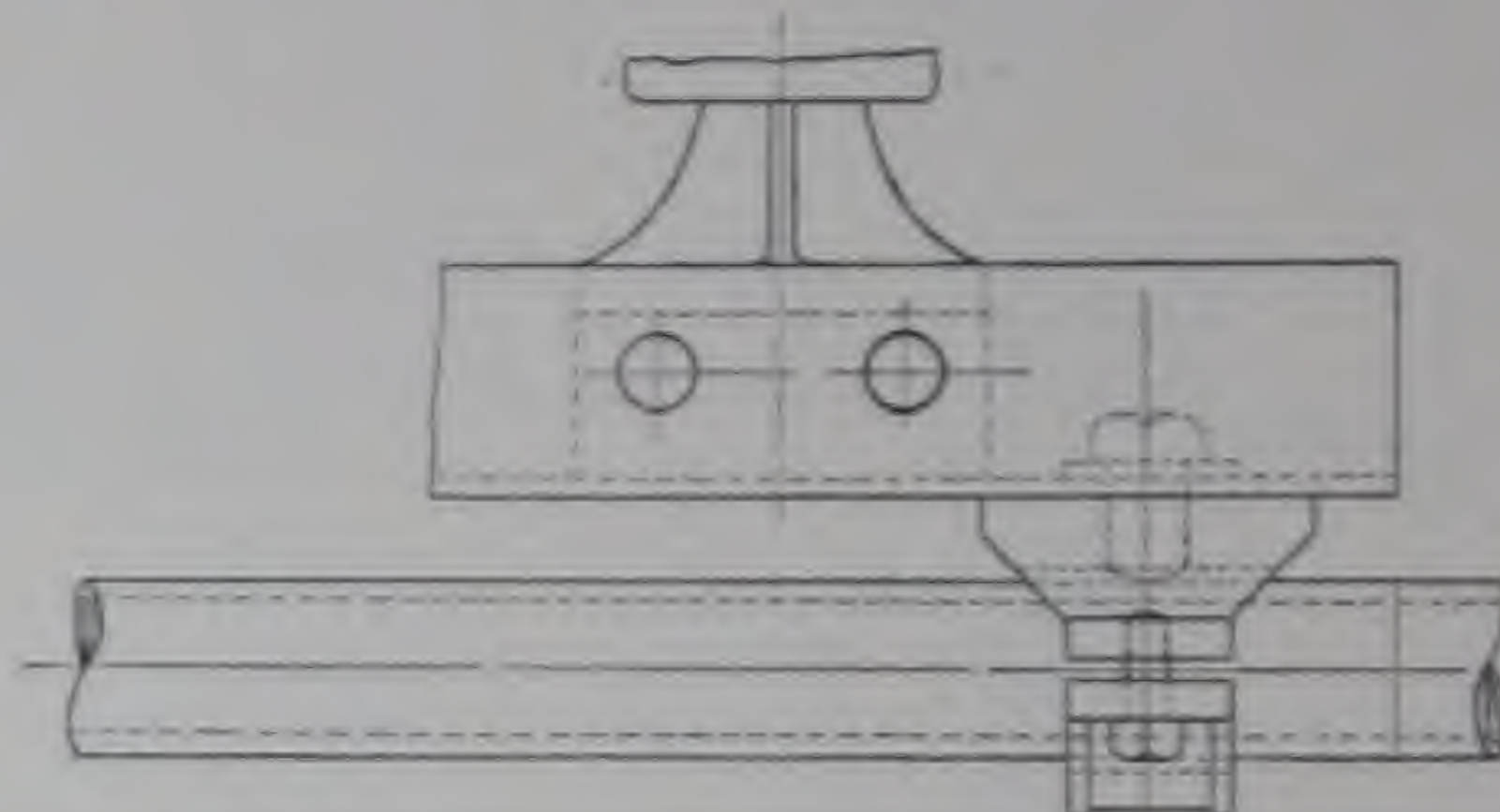
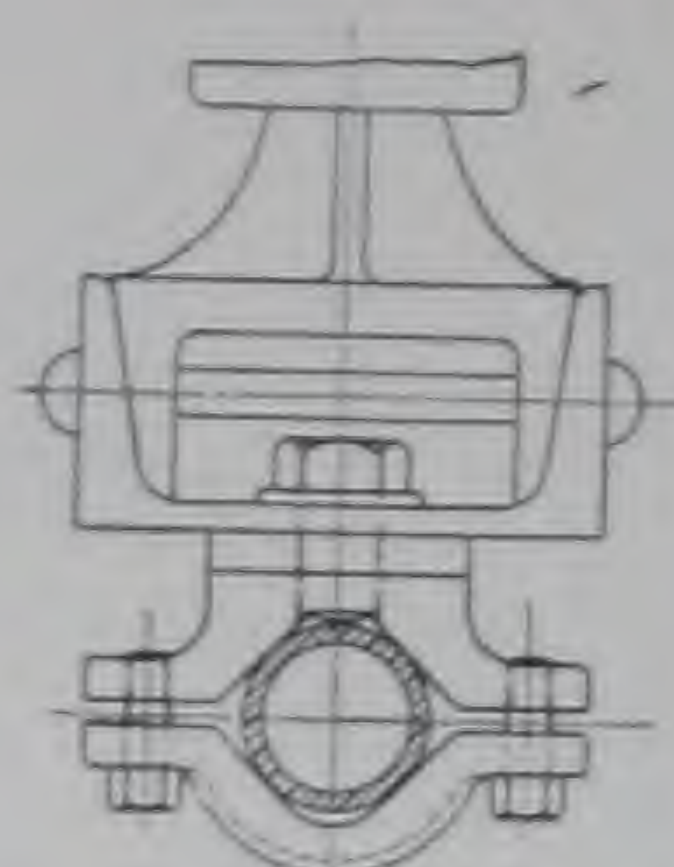
See directions for ordering switches on page 54.

List No.	Voltage	Capacity	List Price
50557	Up to 2,500	100 Amp.	\$14.50
50558	Up to 2,500	200 "	15.00
50559	Up to 2,500	300 "	17.00
50560	Up to 2,500	400 "	19.50
50561	Up to 2,500	500 "	24.50
50562	Up to 2,500	600 "	28.50
50563	Up to 2,500	800 "	35.00
50564	Up to 2,500	1,000 "	42.00
50565	Up to 2,500	1,200 "	50.00

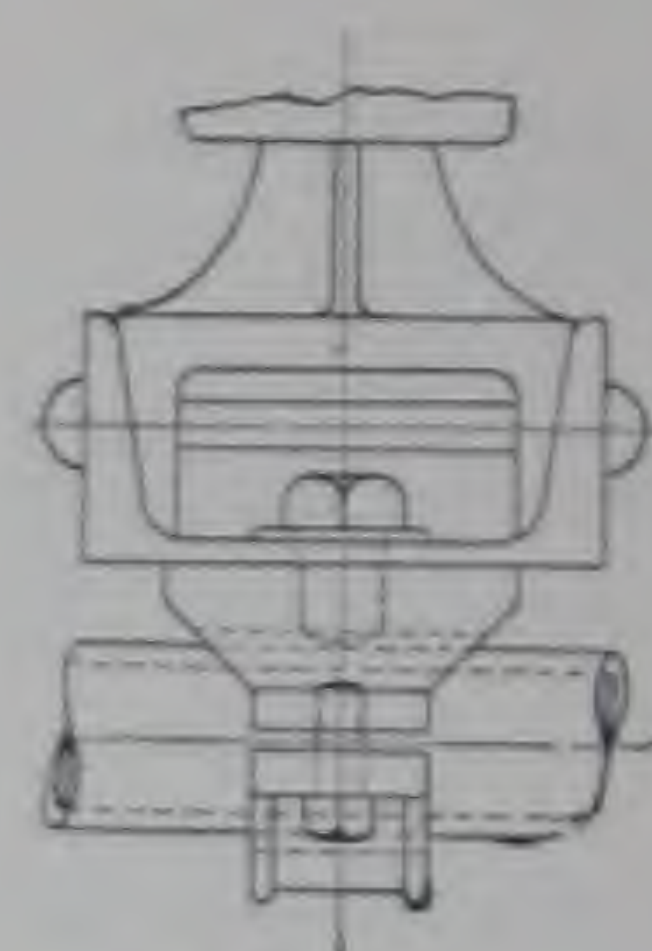
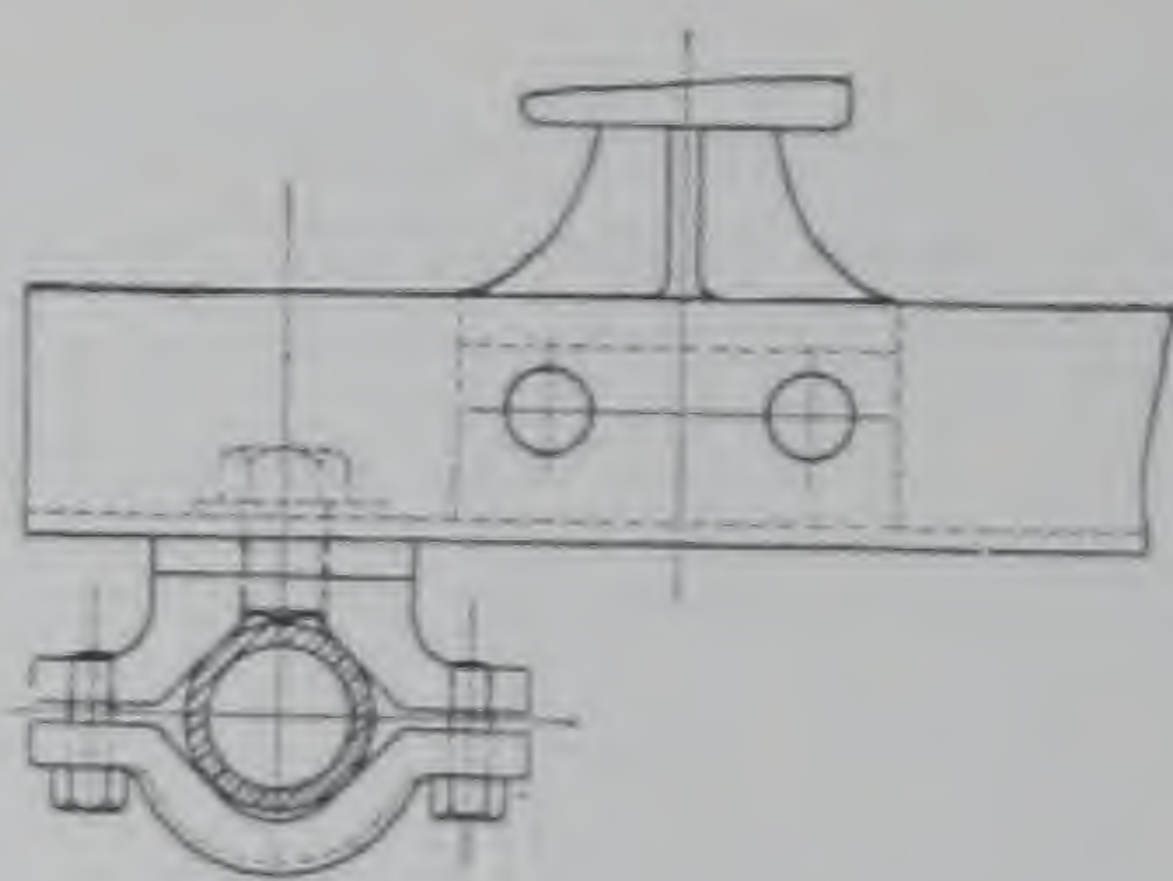


## CHOKE COIL AND SWITCH FITTINGS

## Pipe Clamps



Used with Parallel Pipe Support



Used with Transverse Pipe Support

Four sizes of the above malleable iron Pipe Clamps are listed, any one of which may be used on any Garton-Daniels Choke Coil or Disconnecting Switch, irrespective of voltage or capacity.

They bolt directly to the channel base of either the coil or switch by means of a half-inch stud bolt, and may be used with either two pipes running at right angles to the coil or switch, or with one pipe running parallel to the coil or switch.

Garton-Daniels choke coils and disconnecting switches are not furnished without a channel iron base—except switch type RM—arranged for direct support to pipes by means of pipe clamps attached directly to the insulator pins; this practice is not to be recommended on account of the loss of rigidity occasioned by the absence of the channel base. It has been proven conclusively that a rigid base, a channel iron base preferably, should be the foundation of every choke coil and disconnecting switch, and particularly the latter, so as always to secure perfect alignment of the switch blade with the wipes.

In the construction of all Garton-Daniels choke coils and disconnecting switches, each base is drilled with one  $\frac{1}{8}$ -inch hole in each end; this standard practice enables these pipe clamps to be used with the coils or switches at any time without the necessity of redrilling the base or making any other changes whatsoever. This is an item of great importance to those who may desire at some time to change their method of coil or switch installation.

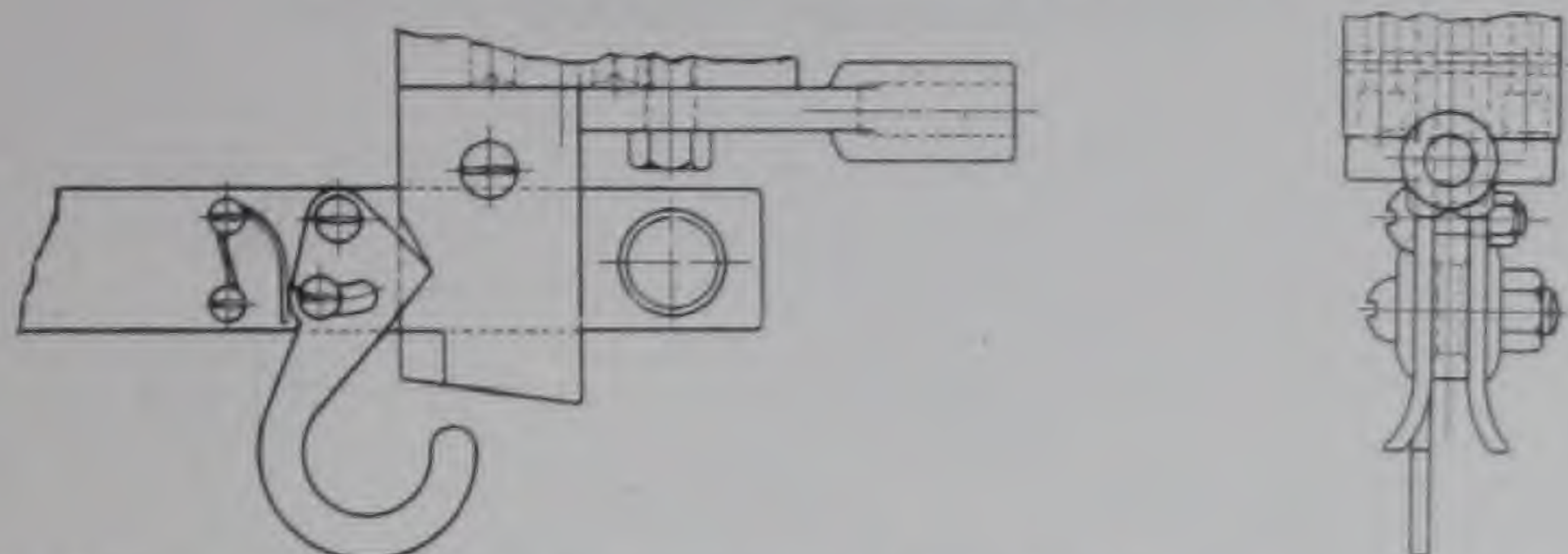
The prices given below include a set of two complete clamps, two complete clamps being required for the installation of one coil or switch.

List No.		List Price Set of Two
50608	Clamp for $\frac{3}{4}$ inch pipe .....	\$1.00
50609	Clamp for 1 inch pipe .....	1.25
50610	Clamp for $1\frac{1}{4}$ inch pipe .....	1.60
50611	Clamp for $1\frac{1}{2}$ inch pipe .....	2.00



## DISCONNECTING SWITCH FITTINGS

## Garton-Daniels Switch Locks



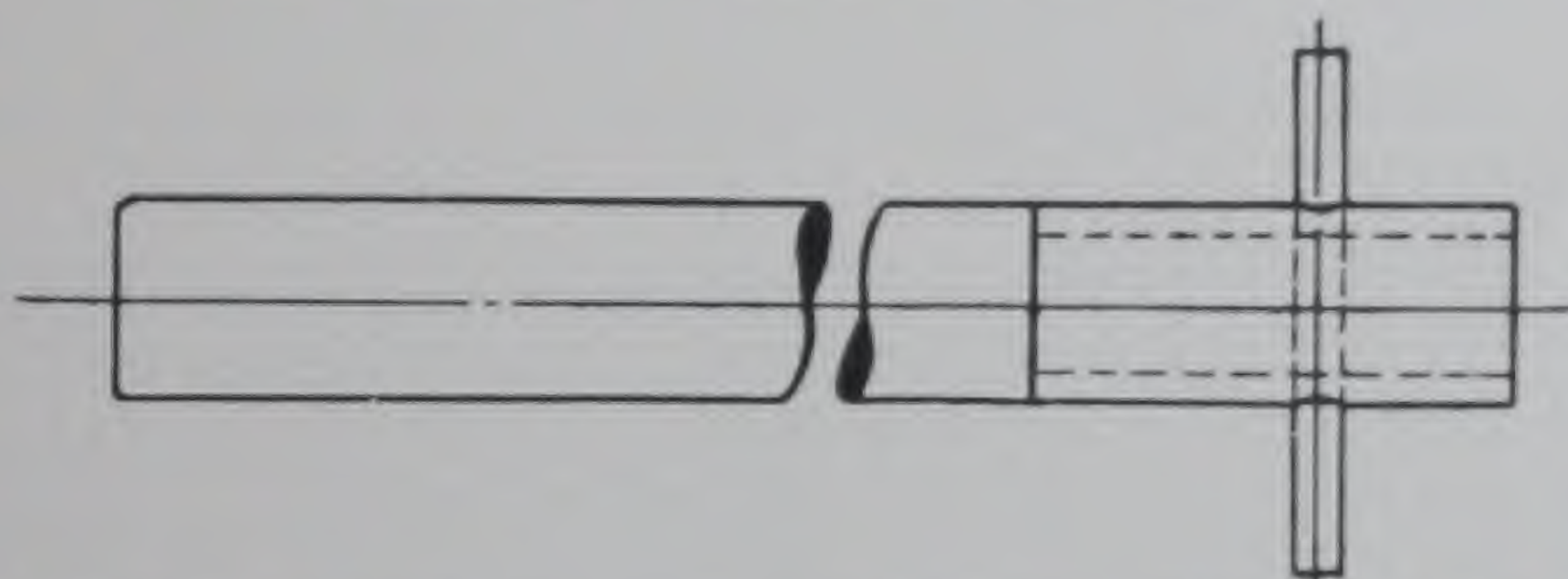
Lock Installed on 200 Ampere, 3000 Volt Type RU Switch

Garton-Daniels switch locks are constructed and mounted on switches, as shown in the above illustration, a typical RU switch being here shown. With any tendency for the blade to be blown open, the catch wedges itself tightly in the slot of the wipe into which it fits, so rendering opening impossible. To open the switch, the switch hook is inserted in the arm of the catch, when a downward pull disengages the catch and allows the switch to be opened; to close the switch the switch hook is inserted in the hole in the blade, the blade pushed in, whereupon the catch locks automatically.

These locks are furnished with every type RU switch as standard; they are recommended for use on types R and RM switches as well. The listing below covers the additional cost of having either of these two types so equipped.

List No.		List Price
50612	Switch Lock installed on Type R Disconnecting Switches of 100, 200 or 300 ampere capacity, add to regular list price of switch .....	\$4.00
50613	Switch Lock installed on Type R Disconnecting Switches of 400, 500, 600, 800, 1000 or 1200 ampere capacity, add to regular list prices of switch .....	4.00

## Garton-Daniels Switch Hooks



Owing to their construction and installation, disconnecting switches cannot be opened or closed by hand; for these purposes, switch hooks are provided. Garton-Daniels switch hooks consist of a well-seasoned wood pole fitted on the end with a metal ferrule and pin. This pin engages in the hole in the blade, and by this means the switches are opened and closed.

The same switch hook may, of course, be used for switches provided with locks, though with this latter construction the arm of the lock is used in opening the switch, while the hole in the blade is used in the closing operation.

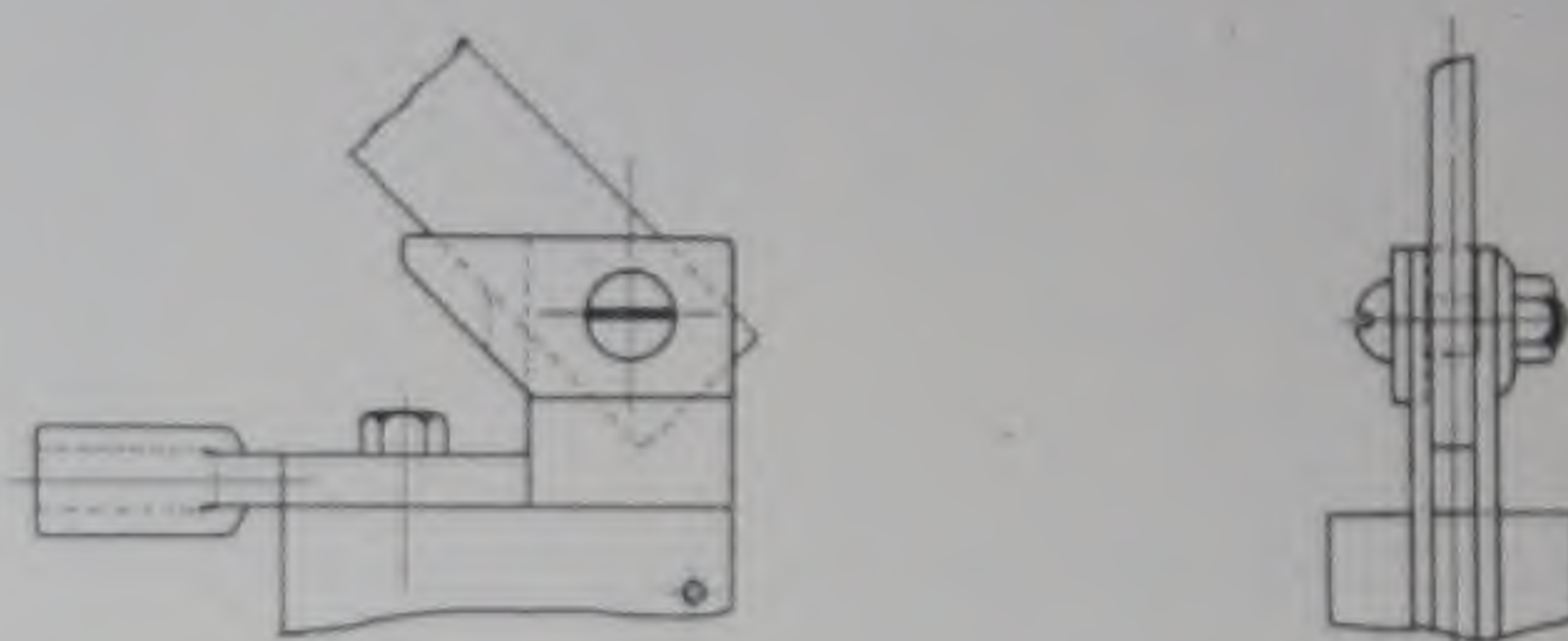
Switch hooks in three standard lengths are listed below.

List No.		List Price
50418	Switch Hook, Any Voltage, 4 feet long .....	\$3.00
50419	Switch Hook, Any Voltage, 8 feet long .....	4.00
50420	Switch Hook, Any Voltage, 12 feet long .....	5.00



## DISCONNECTING SWITCH FITTINGS

## Garton-Daniels Switch Stops



135° Stop Installed on 2000 Ampere, 300 Volt Type R Switch

It is frequently desired that disconnecting switches be provided with blade stops that will prevent the blades being opened beyond a given angle. Garton-Daniels disconnecting switch stops offer a means for readily securing this result. As seen from the illustrations above, showing a 135-degree stop mounted on a 200-ampere type R switch, the stop consists of a brass casting so designed that it may be mounted on one of the rear switch wipes, it being secured in this position by means of the bolt by which the switch blade is held in position. The back of the blade in opening strikes a lug cast on the stop, and so the desired opening is secured.

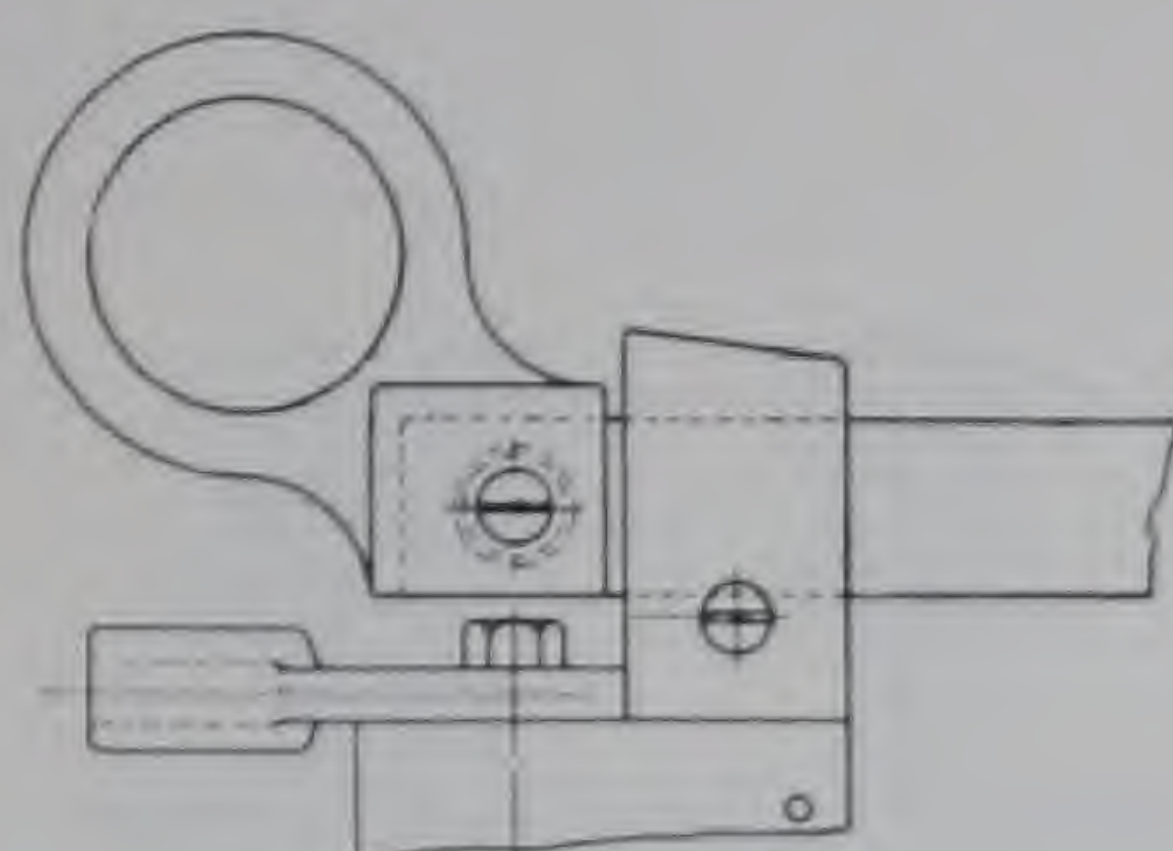
These stops are so designed that they may be mounted on the switch without any machine work whatever; they may be ordered when switches are first ordered, or may be installed on old installations of standard Garton-Daniels switches. They are listed below in various sizes.

List No.		List Price
50600	Switch Blade Operating Attachment for 100 and 200 Amp. Switches	\$1.40
50601	Switch Blade Operating Attachment for 300 Amp. Switches	1.60
50602	Switch Blade Operating Attachment for 400 Amp. Switches	1.90
50603	Switch Blade Operating Attachment for 500 Amp. Switches	2.20
50604	Switch Blade Operating Attachment for 600 Amp. Switches	2.50
50605	Switch Blade Operating Attachment for 800 Amp. Switches	3.00
50606	Switch Blade Operating Attachment for 1000 Amp. Switches	3.50
50607	Switch Blade Operating Attachment for 1200 Amp. Switches	4.00



## DISCONNECTING SWITCH FITTINGS

## Blade Operating Attachment



Blade Operating Attachment Installed on  
23,000 Volt 200 Ampere Type R Switch

Operators have often felt the need for disconnecting switches provided with extra large holes that would facilitate the quick opening of the switch in an emergency.

This need has been met in the design of the above illustrated Garton-Daniels switch blade operating attachment, shown mounted on a 200 ampere type R disconnecting switch.

This attachment is supplied for various sizes of switch blades, as listed below, and is designed to fit over and bolt to the operating end of the blade of any of our standard switches. No machine work is necessary, as the attachment comes ready for installation.

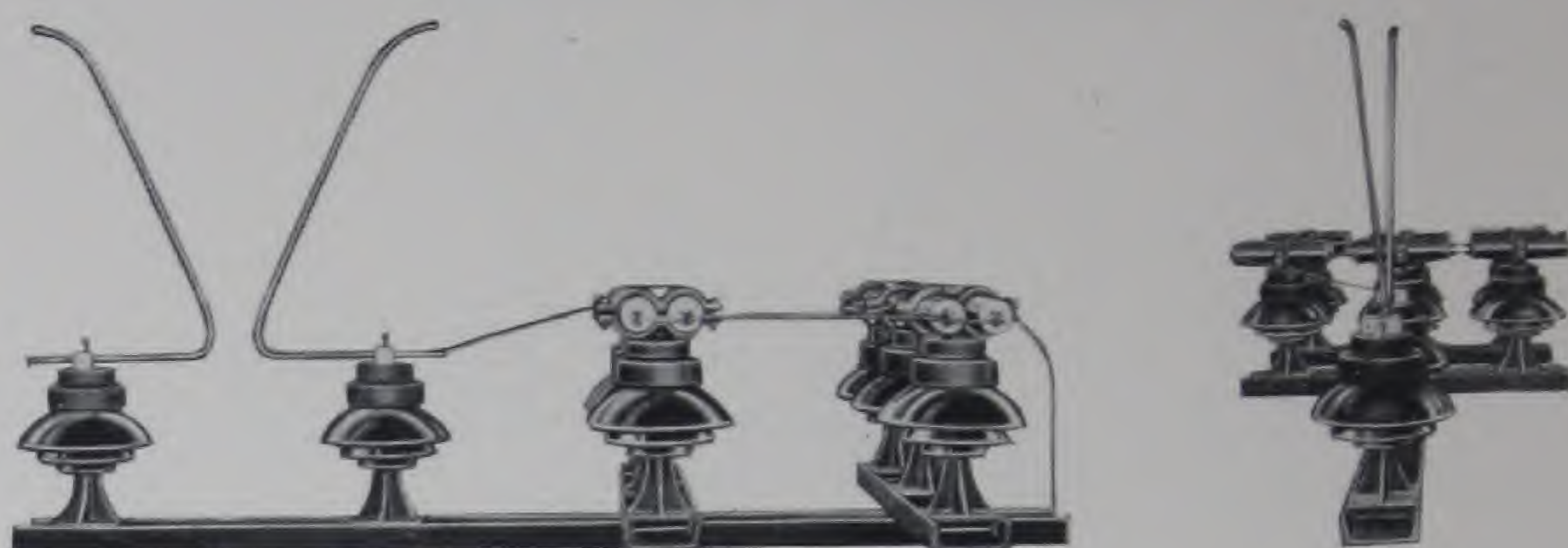
They are made of high-grade cast brass and provide the switch on which used with a  $1\frac{3}{4}$ -inch operating hole instead of the standard  $\frac{5}{8}$ -inch blade hole.

One can readily see the advantages an attachment such as this provides in the matter of ease and facility in opening a disconnecting switch.

List No.		List Price
50614	90° Stop for 100 Amp. Switches .....	\$ .80
50615	90° Stop for 200 Amp. Switches .....	1.00
50616	90° Stop for 300 Amp. Switches .....	1.25
50617	90° Stop for 400 Amp. Switches .....	1.50
50618	90° Stop for 500 Amp. Switches .....	1.75
50619	90° Stop for 600 Amp. Switches .....	2.00
50620	90° Stop for 800 Amp. Switches .....	1.50
50621	90° Stop for 1000 Amp. Switches .....	1.75
50622	90° Stop for 1200 Amp. Switches .....	2.00
50623	135° Stop for 100 Amp. Switches .....	.85
50624	135° Stop for 200 Amp. Switches .....	1.05
50625	135° Stop for 300 Amp. Switches .....	1.30
50626	135° Stop for 400 Amp. Switches .....	1.55
50627	135° Stop for 500 Amp. Switches .....	1.80
50628	135° Stop for 600 Amp. Switches .....	2.10
50629	135° Stop for 800 Amp. Switches .....	1.55
50630	135° Stop for 1000 Amp. Switches .....	1.80
50631	135° Stop for 1200 Amp. Switches .....	2.10



## SPECIAL PROTECTIVE APPARATUS



22,000 Volt Horn Gap Lightning Arrester with  
High Capacity Resistance in Ground Leg

We are in position to design and to furnish special types of lightning protective apparatus for meeting practically every condition; in this class may be mentioned horn gap arresters for indoor or outdoor service, with or without series resistance in the discharge path; combinations of horn gap arresters with choke coils, disconnecting switches, fuses, etc., suitable for the protection of outdoor or other power or sub-station apparatus.

Illustrations above show side and end views of a single pole type horn gap arrester for use on a 22,000-volt, three-phase circuit; this arrester is provided with high capacity series resistance in the ground leg to enable it to discharge for relatively long intervals without destruction to itself or without causing abnormal disturbances on the circuit on which used.

Control apparatus for outdoor or indoor sub-station service is another of our lines; and in short we are prepared to furnish most any class of apparatus having to do with the control or protection of electric circuits.

Correspondence on these or other special types of apparatus is solicited; recommendations and suggestions will gladly be made without obligating the consumer in the slightest to purchase apparatus recommended.

Our success during over a quarter century in this line of work is a fitting recommendation as to our ability to serve you.





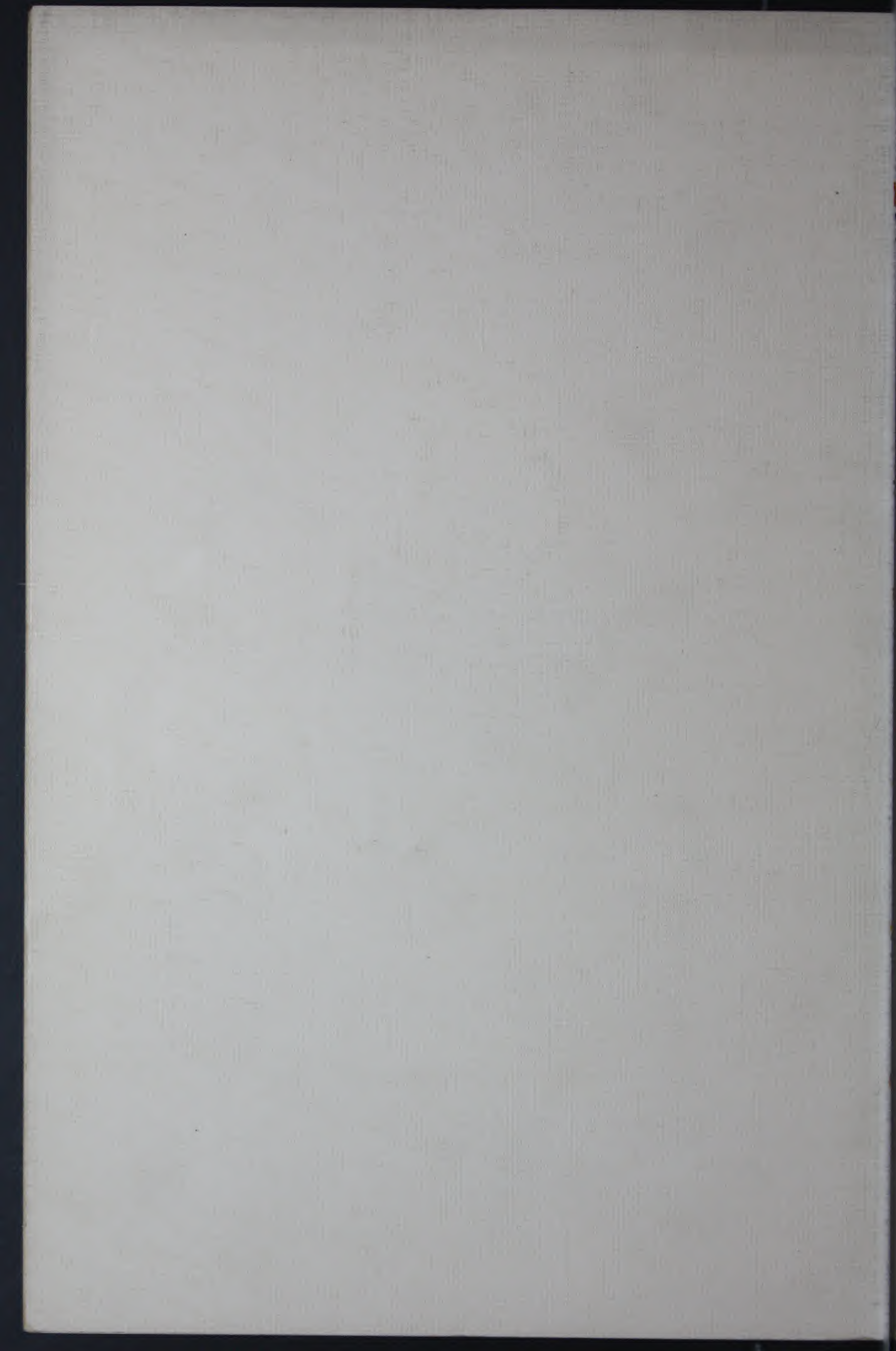














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